339.

INDUSTRIAL ENGINEERING

ELECTRICAL, MECHANICAL AND PLANT SERVICE IN INDUSTRY

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L. C. MORROW, Editor

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When Summer Comes—

. . . With the exception of some seasonal industries, the year's low point in production occurs during the summer months.

. . . Obviously production will be least impaired if changes in equipment are made at this time.

. . . The plant engineer who consistently looks ahead—who pushes his job—has already decided upon his replacement, repair, and modernization programs. He also has his plans concerning building maintenance.

. . . His inspection and performance records have furnished a statement of conditions throughout the plant. They have indicated the weak links in the service-to-production parts of the production chain.

. . . Here a new motor is required; there a speed reducer; in another unit, new belts; throughout the plant attention to clutches, couplings, chain and gear drives, with the substitution of new parts or new units.

. . . The lighting system requires changes, the substitution of more efficient units, extension into dark quarters.

. . . Walls and ceilings are dull and absorb too much of the artificial light furnished during the winter months.

. . . There are cold corners or portions of the plant where the addition of a heating unit would increase output.

. . . Floors are bumpy, roofs may be leaky, glass may be broken.

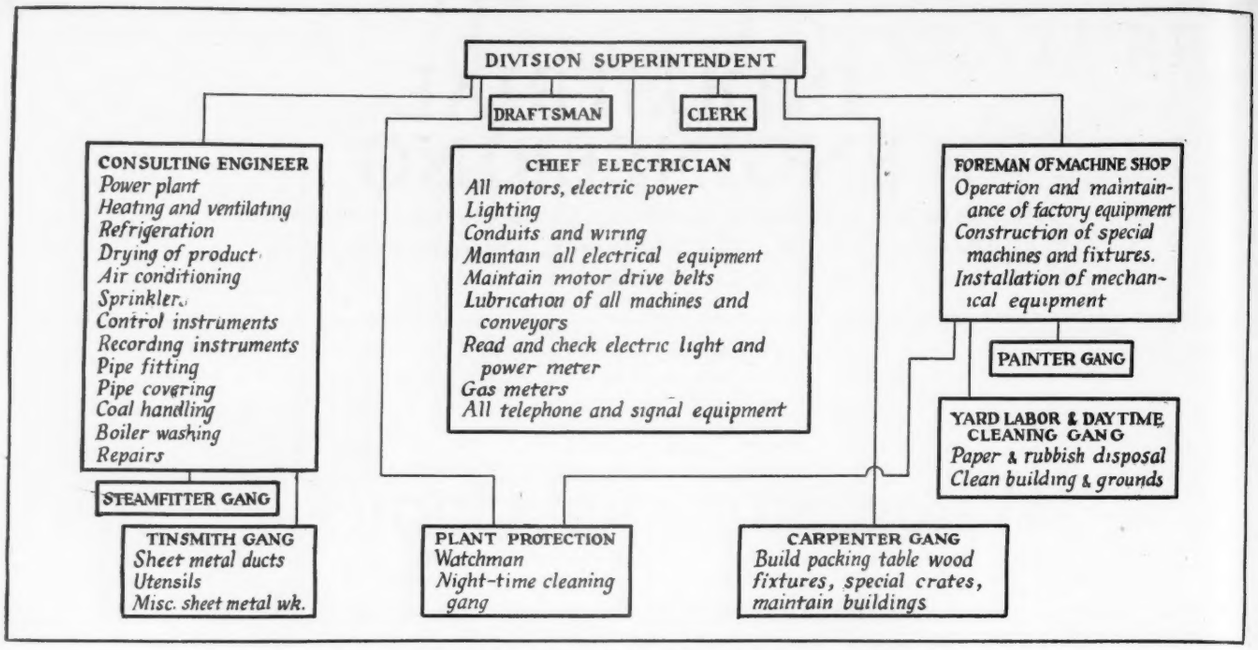
. . . Better lubrication systems or devices may be needed.

. . . There are many other details, such as requirements for replacement conveyor parts, extension of materials handling system, new cables for cranes, elevators, and hoists.

. . . If the plant closes down for inventory the plant engineering department can carry out its program without interference. When Saturdays are holidays the rebuilding work can go on then. Otherwise night work or the shutting down of part of a department at a time must be depended upon.

. . . Only a few of the instances where betterment is needed cannot be determined in advance, by a plant engineering department that indulges in routine inspection and maintains the right kind and quantity of records.

. . . With advance knowledge of conditions there is no reason why the replacement parts and new equipment should not be on hand in advance, so that the plant engineering department can take full advantage of all opportunities for rebuilding offered during the summer months.



Organization chart for the division of mechanical operation, construction and maintenance.

ORGANIZATION for Plant Operation and Maintenance

E. J. Brach & Sons
Candy Makers, Chicago

As told by the Mechanical Superintendent
to W. A. Beck, Managing Editor

ACCORDING to statistics candy making ranks about thirty-fifth in the line of major industries and it is one industry which is typical of the evolution of home-made products. Laboratories have replaced the old-fashioned kitchen and equipment manufacturers supply the machinery for mass-production operation that is absolutely necessary if the supply is to meet the demand. Few people, if any, realize the extent of the organization needed to successfully conduct the operations that are not unrelated to those of production alone. For our purpose these may be termed service-to-production operations in this article since they deal with the personnel not directly engaged in candy making.

In contrast to other industries, for example, metal working, candy makers only supervise the product and we do not permit them under any circumstances to make machine adjustments no matter how slight they may be. A candy maker is not permitted to have any tools other than those required by his trade. When he is found to have them in his possession we see that they are taken away from him. The metal worker, however, is quite free to make the adjustments necessary to his machinery because that is as it should be. We must make certain restrictions if the responsibility for equipment is to be delegated to a particular group which in this plant is known as the division of mechanical operation, construction and maintenance and whose duty it is to supervise new construction, maintain buildings, grounds, streets, railroad tracks and all factory equipment.

Our plant is under one roof, taking up an area of one square block, which is augmented by another square block of yards and railroad facilities. It is three stories in height and all but a portion of one floor which is used for general offices, is utilized for the manufacture of candy. Storage tanks for corn and other syrups are located underground beneath one portion of the building. This material is discharged from the tank cars on the yard tracks directly to the tanks below. Delivery to the points where the material is used is made by means of pumps. The processes are more or less continuous and the materials progress from the upper floors to the storage room and to the shipping platform in an orderly manner, similar in a good many respects to other manufacturing industries. Processes of this kind require extensive material handling devices and power-driven machinery that were unheard of in the early days of candy making, particularly when it was confined to the home or small manufacturer.

With the exception of the boiler plant auxiliaries all machinery in and about the plant is driven by electricity which is purchased at the

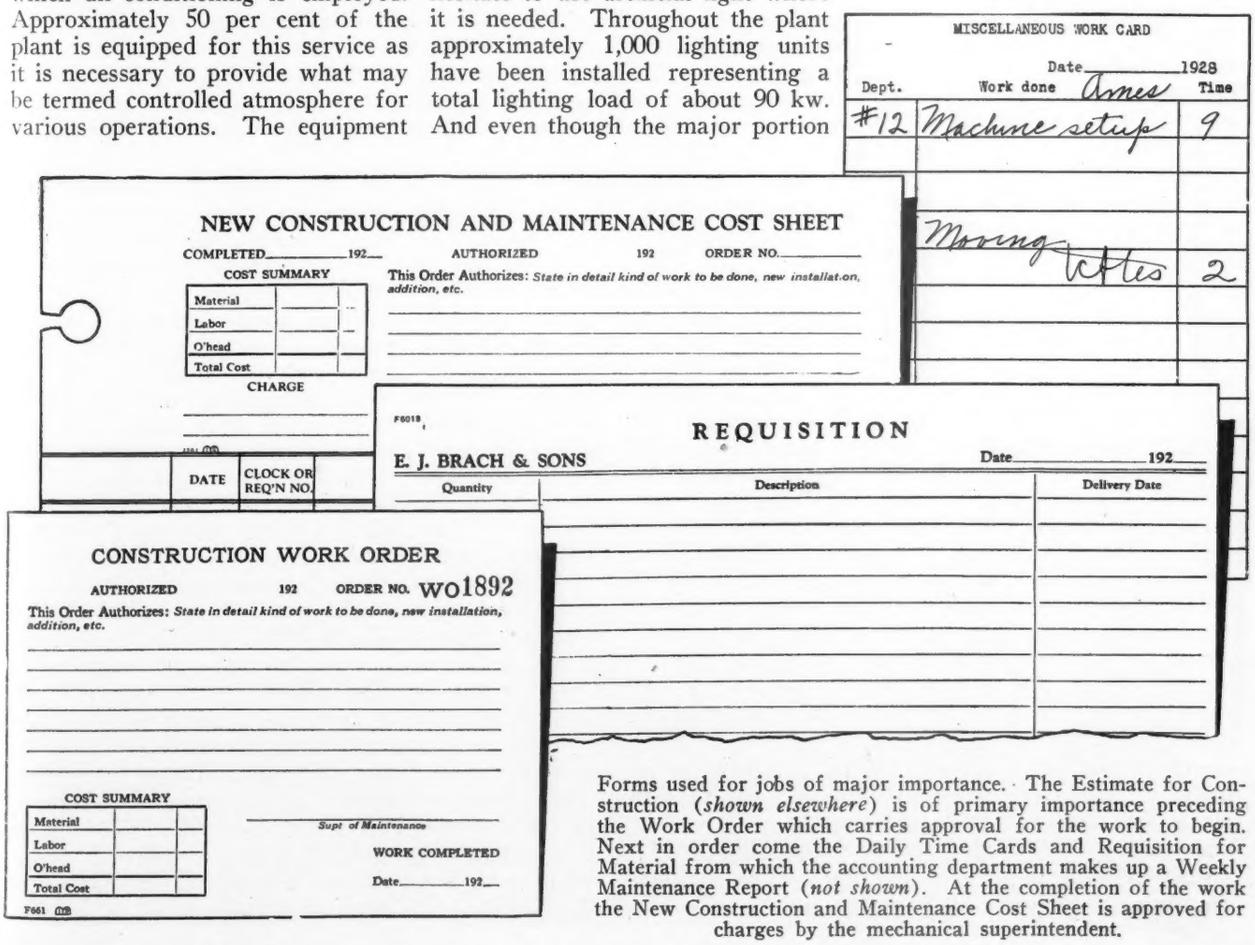
prevailing rates in this locality. We have a bank of 12,000/220-volt transformers totaling 2,000 kva. for power and one 100 kva. transformer for lighting located in a vault on the first floor of the building, access to which is denied employees except in cases of emergency; however, central station employees who come in to read the meters, which are on the primary side of the incoming lines, are permitted to enter at will, but then only when accompanied by a plant representative. The secondary distribution about the plant is maintained at 220 volts without the use of meters in these circuits. For normal operating activities we are not concerned so much about the power consumption but when it is desired to know what a certain department is doing with the power furnished, meters are cut into the circuits, feeding that department so that this information can be obtained. This information forms the basis of charges for power against this department until subsequent changes warrant the making of another test.

The power demand varies considerably with the seasons of the year principally because of the extent to which air-conditioning is employed. Approximately 50 per cent of the plant is equipped for this service as it is necessary to provide what may be termed controlled atmosphere for various operations. The equipment provided for this service consists of two 125-hp. 100-ton and three 30-hp. 30-ton refrigerating units which are located on the first floor. With these units we obtain a flexibility that results in a very high efficiency of operation. Equivalent refrigeration in multiples of 30 tons and so on can be had to meet almost any outside weather condition without overloading the plant capacity or wasting valuable power. These units are the largest in the plant in motor capacity, the total of which is 1,650 hp. made up from 400 motors, many of which are in continuous service throughout the entire day.

Steam for process cooking, drying and dehumidifying, also plant heating is generated in one 750-hp. boiler which is taken off the line twice a year for general overhauling and inspection. When this boiler is out of service three 72-in. standard return tubular boilers in stand-by service carry the total load.

Inasmuch as our plant is of modern construction, reinforced concrete faced with brick and terra cotta, and equipped with exceptionally large windows, illumination is a secondary problem, nevertheless we do not hesitate to use artificial light where it is needed. Throughout the plant approximately 1,000 lighting units have been installed representing a total lighting load of about 90 kw. And even though the major portion of the work is carried on during daylight hours, several departments have need for light very early in the morning. For instance, the cookers come to work several hours in advance of the other employees so that material will be available at starting time, hence they must have light. In the office as in other portions of the plant light reflecting paints are generously applied to supplement the general lighting.

To carry on the activities in this one division a force of 65 men is required and which is divided as shown on the organization chart on another page into departments according to the men's activities. The engineering department comes under the supervision of the division superintendent but the steam fitting gang and the tinsmith gang report to the engineer in charge in the engineering department. The chief electrician is only responsible for his force which consists of electricians, oilers, meter readers and so on. The machine shop foreman, however, is also responsible to the division superintendent for the painters, yard laborers and day-time cleaning gang, paper and rubbish disposal, etc.,


MISCELLANEOUS WORK CARD

Date Jones 1928

Dept.	Work done	Time
#12	Machine setup	9
	Moving tables	2

NEW CONSTRUCTION AND MAINTENANCE COST SHEET

COMPLETED 192 AUTHORIZED 192 ORDER NO.

COST SUMMARY

Material		
Labor		
O'head		
Total Cost		

CHARGE

This Order Authorizes: *State in detail kind of work to be done, new installation, addition, etc.*

DATE	CLOCK OR REQ'N NO.	

REQUISITION

E. J. BRACH & SONS Date 192

Quantity	Description	Delivery Date

CONSTRUCTION WORK ORDER

AUTHORIZED 192 ORDER NO. WO1892

This Order Authorizes: *State in detail kind of work to be done, new installation, addition, etc.*

COST SUMMARY

Material		
Labor		
O'head		
Total Cost		

Supt of Maintenance

WORK COMPLETED

Date 192

F661

Forms used for jobs of major importance. The Estimate for Construction (*shown elsewhere*) is of primary importance preceding the Work Order which carries approval for the work to begin. Next in order come the Daily Time Cards and Requisition for Material from which the accounting department makes up a Weekly Maintenance Report (*not shown*). At the completion of the work the New Construction and Maintenance Cost Sheet is approved for charges by the mechanical superintendent.

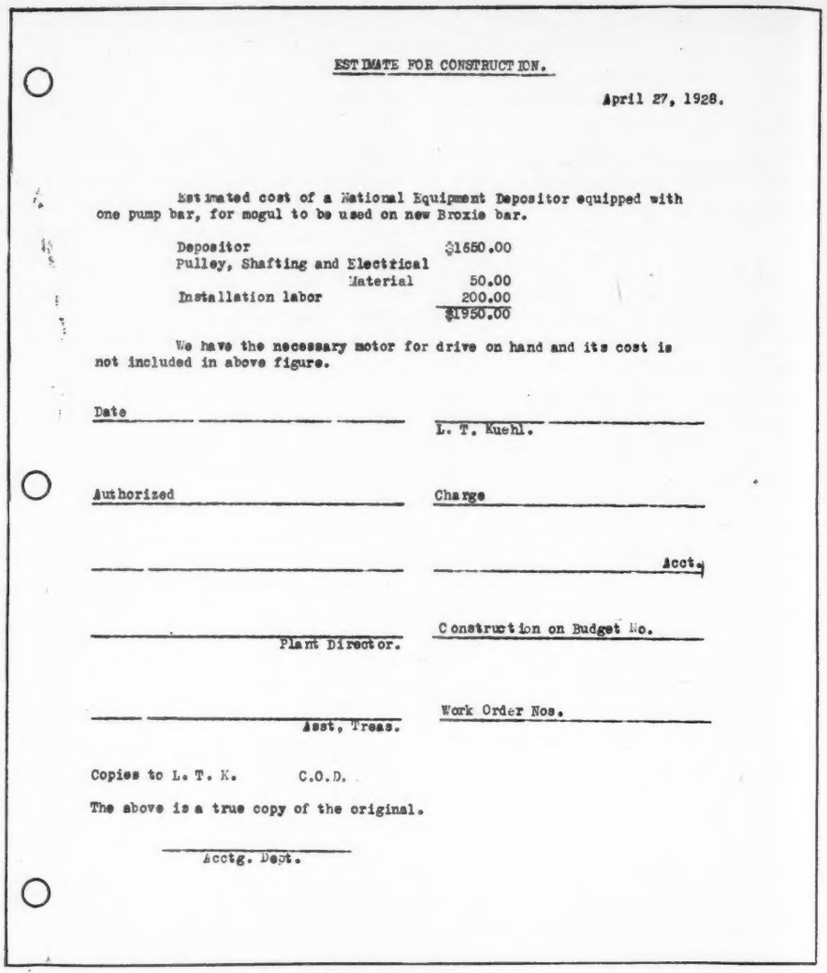
and he divides the responsibility for plant protection supervision with the division superintendent. Either executive must be available in case of emergency at any hour of the day. The carpenter gang like the electrical force reports directly to the division superintendent through the foreman.

It has been found by experience that an organization so constituted is almost ideal for our purpose because there is no overlapping of duties. Everything related to steam, water, heat, air, etc., is referred to the engineering department but where the machine shop is really responsible for the operation and maintenance of factory equipment, it has nothing whatever to do with the lubrication of the equipment. An oiler is carried on the electrical department pay roll who sees that every bearing in the plant is inspected every day and lubricated, if it is required. Because of the elimination of bearing failures since this oiler has been on this job, we consider him to be one of the most valuable men in the plant. If in making his rounds a condition is observed that he cannot correct at once, he makes a note of it if the repairs can wait, but if immediate attention is necessary he notifies the foreman whose duty it would be to correct it. Sometimes the foreman in that department can do all the repair work necessary, but in the event that he cannot master the situation he is at liberty to make a request on the other departments. This condition is especially true with labor. Where the job at hand is relocating equipment such as machinery from one floor to another, candy makers cannot be used so the yard gang must supply the men required, and at the completion of the work these men return to their former work. All requests for laborers from the yard gang must clear through the machine shop foreman who keeps close watch on their activities.

In cases of this kind where the expense is nominal, that is, where perhaps two or three hours overtime is necessary no formality governs the actions of those in charge of the various departments. The division superintendent is acquainted with all the requirements of the job by the department head or heads and he issues the order to his department accordingly. If, however, it is desired to obtain full costs on the move, he makes out a Work Order which describes the work to be done, and the accounting department sets up an account against the job to which all expenses (time and material) are charged. Before any action is taken on a move that involves changes of location for certain equipment, a blue print is made showing the proposed changes and to which all foremen concerned must approve before the change is authorized. The workmen engaged on the job must confine themselves to the dimensions and machine location given so that proper charges for floor rental based on the space occupied can be made. Having the various foremen approve the plans insures that the procedure is correct and that no interference will be forthcoming from unexpected obstacles such as steam or water lines if the engineering department had not been consulted and similarly with the electrical services.

Where a job, however, is of greater magnitude than those referred to, a procedure is followed that has been found to far exceed our expectations. Before going further it may be well to state that we do not budget maintenance even though we know approximately that cost on a unit basis, but we do consider all other items in plant housekeeping.

When certain changes are proposed in plant equipment which necessitate the installation of additional equipment, an Estimate for Construction is requested and made up for the approval of the various department heads and executives. It is no more than a detailed list of the various factors entering into the cost of the completed job. The approval of this estimate amounts to authority to proceed with the work inasmuch as it bears the signature of the proper parties. The assistant treasurer then sets up an account for the job and a Work Order is issued in turn. With the Work Order instructions are issued to the departments supervised by the division superintendent outlining the work required by them, although if the work is of a minor nature these instructions are likely to be given verbally.



ESTIMATE FOR CONSTRUCTION.

April 27, 1928.

Estimated cost of a National Equipment Depositor equipped with one pump bar, for mogul to be used on new Broxie bar.

Depositor	$1650.00
Pulley, Shafting and Electrical Material	50.00
Installation labor	200.00
	$1950.00

We have the necessary motor for drive on hand and its cost is not included in above figure.

Date _____ L. T. Kuehl.

Authorized _____ Charge _____

_____ Acct.

_____ Construction on Budget No.
Plant Director.

_____ Work Order Nos.
Asst. Treas.

Copies to L. T. K. C.O.D.

The above is a true copy of the original.

_____
Acctg. Dept.

All work of major importance is instituted by an investigation of the probable costs. An Estimate for Construction is reproduced from the original.

The men then engaged on this work fill in daily time cards which show the distribution of their time and which are approved if they show the proper charge by the division superintendent who forwards them to the accounting department where the charges are allocated to the various jobs under way.

Each week the accounting department renders a Weekly Maintenance Report to the division superintendent which in a way indicates the progress of the work and how the money set aside by the accounting department for the work is being spent. This report includes the labor charges in addition to the material requisitioned for the job. These requisitions likewise must bear the approval of the division superintendent although they may be issued by any one of the foremen engaged on the job. This procedure insures that no material will be purchased by one department without some one knowing that it is already in stock in another department. No general stores are kept so the supervision in this respect is very rigid. Each department has its own stores under a perpetual inventory control. All stock purchased is immediately charged to that department and a draw-off card covers the disbursement of each item so that a record is available at all times as to the amount of stock or spare parts on hand. When the particular job is finished, that is, the one on which a Work Order has been issued, a New Construction and Maintenance Cost Sheet is made up by the accounting department and sent to the division superintendent for perusal, particularly for verification of the various charges against the job. The signature of the division superintendent concludes the transaction and as it is stamped on the face of the sheet, W. O. Complete.

Among the other services which come under the direction of the division superintendent are reconstruction and plant betterment. Old machines are rebuilt and new machines, regardless of the design, are changed to conform to plant standards. Betterment includes all improvements to plant and equipment.

Each manufacturing department in the plant has its mechanic who makes all necessary adjustments to the machines under the supervision of the machinist foreman. He has his bench and necessary tools in his department but if the work at hand calls for assistance from an electrician a request is made through his foreman to the chief electrician who sends one or more electricians as the case may be. This system also applies to any other department engaged in service-to-production.

Inspections are made regularly of metering equipment, sprinkler systems and plant structures. In the first case, certain meters are inspected and calibrated weekly. Power meters are read only at stated intervals inasmuch as the various circuits in the plant are not equipped with meters. A steam fitter who inspects the sprinkler system is also in charge of all control instruments in the plant. This man changes the paper disks on the recording instruments daily, calibrating all meters that he is responsible for every week. Fire inspection is carried on weekly with the aid of a regular insurance form by an employee from the machine shop, and who is regularly employed as a machinist. He is responsible for fire doors and so on.

Reflectors and globes in the illuminating equipment in the offices are cleaned mostly on Sundays by members of the yard gang. Two men are usually employed for this work and they clean 240 reflectors in about 12 hours' time.

Plant housekeeping is an important function of our division. Cleaning machines, work space or in fact, everything except the sweeping of the receiving and the shipping department floors is done by employees who are trained for that purpose.

Production workers apply themselves to production only and when the day's run of goods is finished and a manufacturing department foreman and his workers leave for the day, they know that upon their return to work the following day the machines and equipment will not only be cleaned but thoroughly sterilized as well, the floors in and about the machines scrubbed scrupulously clean and dry, also all belts and shafting in the power transmission line relieved of the dust that accumulated during the day.

Because of seasonal demands for certain products many departments work overtime and over week ends, so in order to acquaint the foremen of the subdivisions of the maintenance group with week-end activities, a typewritten order is passed from foreman to foreman to enable them to gage the number of men needed for the various jobs that must be attended to during this period. No copies are made of this order except by the foremen who have work to do. It so happens that a single copy produces the best results as it encourages a man to be very careful in getting his instructions. Duplicate copies are usually mislaid with the result that considerable confusion is experienced which is detrimental to the best interest of the men and the plant.

Types of Bearings Used in

Transmission of Power

By WILLIAM STANIAR

Chairman of the Advisory Board
Power Transmission Association
Power Transmission Engineer
E. I. du Pont de Nemours & Company
and Subsidiaries
Wilmington, Del.

NUMEROUS types and styles of bearings are manufactured for industrial power transmission devices, and although each one has its place in the field, it is difficult at times to decide just what type or style to use for a given condition. The subject of bearings is a broad one because in every mechanical operation, bearings of some description are employed; hence this discussion will be confined to the practical application of bearings for power shafting. The factors that determine the selection of any given design or type for this purpose are as follows:

1. Diameter of shaft.
2. Speed of shaft.
3. Power transmitted and load.
4. Supporting structure.
5. Lubrication and maintenance costs.
6. Cost of bearing.
7. Space limitations.
8. Operating conditions.

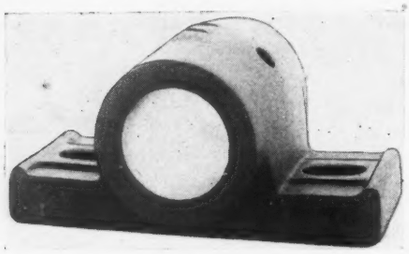


Fig. 1—The solid babbitted bearing.

* * * *

In plain bearings the surface which contacts the shaft is made of brass, bronze, or antifriction metals, and in some cases cast iron. The bearing surface is always made of a metal softer than the shaft itself, so that as wear occurs it will be chiefly in the bearing, as this can be more easily replaced than the shaft.

Babbitt metals are combinations of hard metal, such as antimony, mixed in varying proportions with lead and tin, forming babbitt or white metals known as antifriction metals. When bearings are lined with suitable babbitt metal the shaft readily beds itself down and distributes its weight uniformly over the entire bearing surface. Most bearings used for power-transmission shafting are lined with antifriction or babbitt metal.

When shafting is erected it is extremely important that the various bearings be accurately aligned. When some bearings are placed too high and others too low, or not in line, stresses will be set up in the shaft and bearings that will produce high bearing temperatures.

Bearing Temperatures.—The temperatures of bearings in service are termed "moderate" or "extreme." Moderate temperatures may be considered those not higher than 140 deg. F. This temperature is easily held in industrial shafting installations if alignment, lubrication, and loading are correct.

High temperatures, above 140 deg.

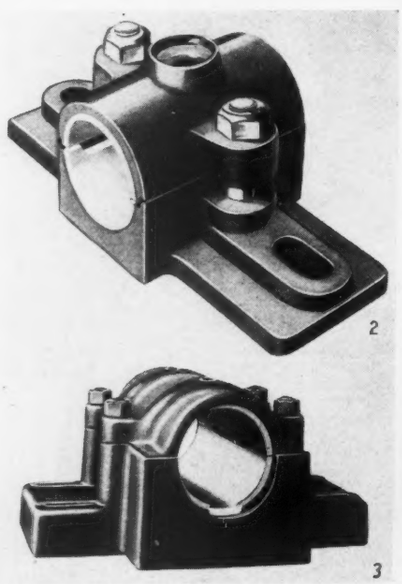


Fig. 2—The split flat box. Fig. 3—One type of self-oiling, rigid pillow block.

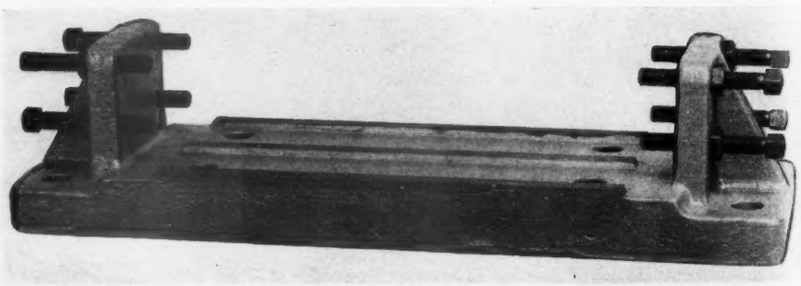


Fig. 4—Plain baseplate for mounting rigid pillow blocks on concrete piers or timber framework.

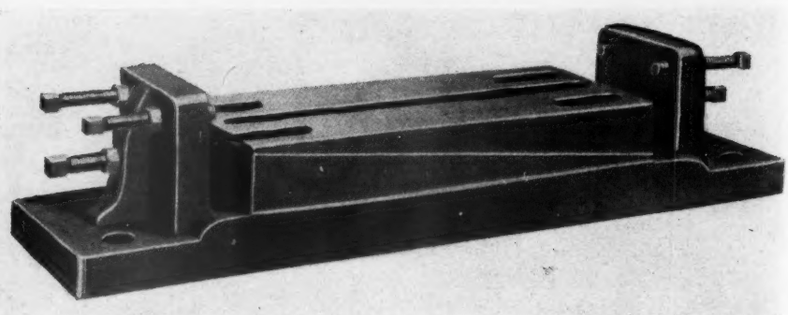


Fig. 5—An adjustable baseplate is used when several pillow blocks are required on a long line- or headshaft supported on concrete or timbers.

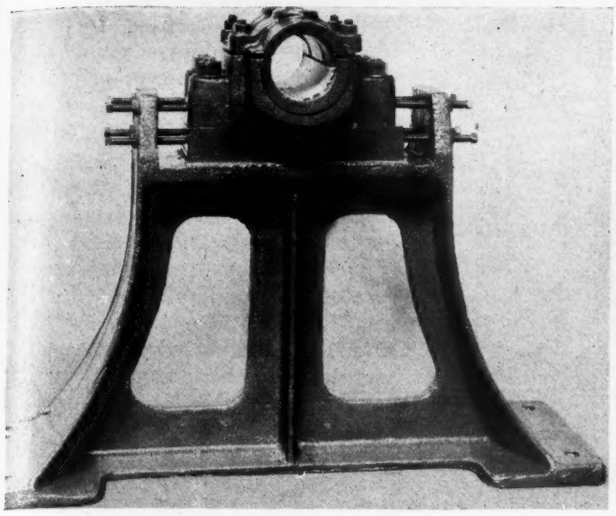


Fig. 6—Cast-iron floor stand with adjustable wedges.

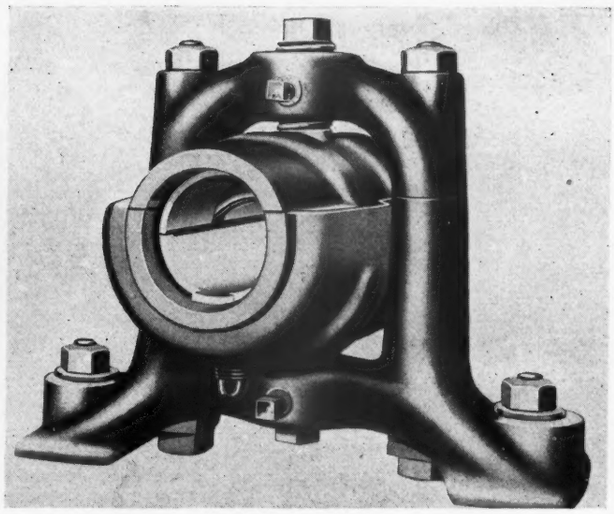


Fig. 7—Ball-and-socket type, self-oiling pillow block.

F., are due to deficient radiation, internal friction, or the effect of high surrounding temperatures.

High temperatures resulting from internal friction may be caused by one of the following conditions:

1. The mechanical conditions may be wrong.
2. An improperly selected oil may be in use.
3. An insufficient quantity of oil is reaching the parts to be lubricated.

Types of Plain Bearings and Their Uses

For the industrial transmission of power there are available various types of good bearings, and if they are employed under the mechanical conditions for which they are designed they will give efficient and economical service.

Solid-Babbitted Bearings. — This type, shown in Fig. 1, is of cast iron and babbitted. It should be used on shafting or axles under $4\frac{7}{16}$ in. diameter revolving at slow speed and where adjustment is not necessary. Lubrication is by grease cup or plain oiling.

The Split Flat Box.—This type, Fig. 2, is of cast iron, babbitted and furnished with a cap. It is extentively employed where moderate powers and speeds are involved. This bearing has no adjustment, with the exception of a slight horizontal movement. It should not be employed on shafting over $3\frac{15}{16}$ in. diameter. Grease or oil can be used as a lubricant.

Plain-Oiling Rigid Pillow Block.—This type is of cast iron, babbitted and furnished with a four-bolt cap when used with shafts from $2\frac{15}{16}$ to 15 in. in diameter. Below $2\frac{15}{16}$ in. two bolts are in the cap. This bearing is of heavier construction than the split flat box and, therefore, is suitable for almost any load on slow-speed shafting. This bearing should always be rigidly supported, and grease lubrication is preferable.

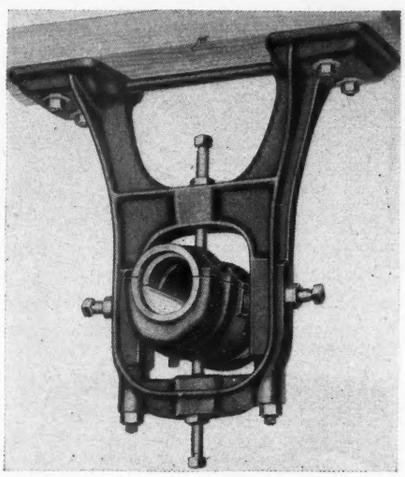


Fig. 8—One type of four-point suspension, cast-iron drop hanger.

* * * *

Self-Oiling Rigid Pillow Blocks.—These bearings, Fig. 3, are of rugged, cast-iron construction, babbitted, and designed to feed oil to the shaft automatically either by the ring, chain, collar, or capillary method.

This type of bearing should be used on the average headshaft when supported from the floor, a concrete foundation, or a wall. When a two-bearing headshaft is supported on concrete or timbers, these bearings should rest on the plain baseplates shown in Fig. 4. When three or four bearings are used on a long headshaft, or the average lineshaft supported on concrete piers or timbers, the adjustable baseplate, Fig. 5, should be employed. If supported from a wooden or cement floor, either for head- or lineshaft, the cast-iron floor stand with adjusting wedges, Fig. 6, should be used.

Angle, Self-Oiling, Rigid Pillow Block.—This possesses all the characteristics of the regular, self-oiling rigid pillow block, with the exception that the split is at an angle of approximately 45 deg. This bearing should be employed when a severe power pull is directly on the cap. The angle allows the main part of the bearing or the pedestal to take its proportion of the load.

The turned-liner, rigid pillow block is designed to be even more rigid than the regular type. The body of

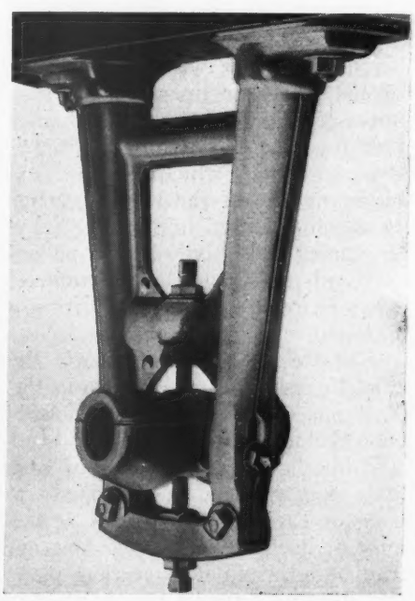
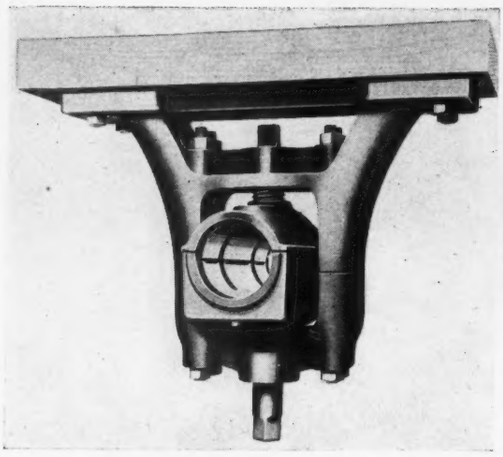


Fig. 9—A pressed-steel, four-point suspension, drop hanger.



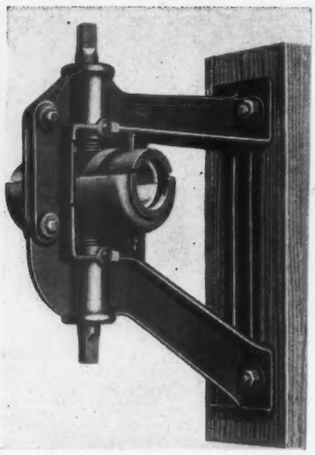


Fig. 10—This ball-and-socket drop hanger is designed for supporting heavy headshafts. Fig. 11—A cast-iron, ball-and-socket wall hanger.

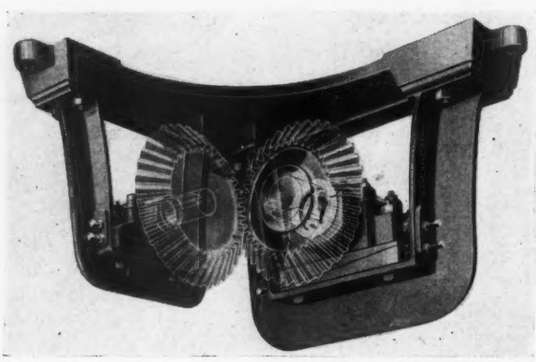


Fig. 12—Cast-iron sling hangers make a desirable support for shafts that are connected by gears.

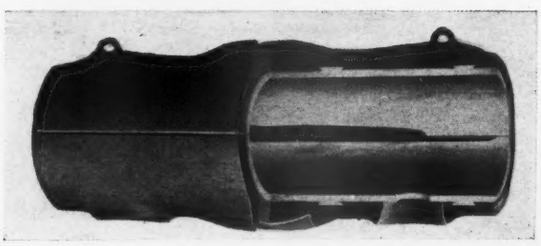


Fig. 13—A plain babbitted hanger bearing.

the bearing has three or four ridges bored concentric with it to receive turned ridges or liners on the babbitt-receiving portion of the bearing; therefore there is a finished metal-to-metal contact which results in extreme rigidity of the whole bearing. It should be used immediately next to gearing and heavily-loaded pulleys on head- and short lineshafting, or when extreme rigidity of shafting is required.

Ball-and-Socket, Self-Oiling Pillow Block.—This type, shown in Fig. 7, is one of the most serviceable of pillow blocks for general long head- and lineshaft service. It is of cast-iron construction, is equipped for ring or capillary oiling, can accommodate itself to shaft movement, and can be adjusted in a vertical plane. Its chief uses are on long headshafts and lineshafts when supported from concrete piers or timbers, and particularly on lineshafting supported from walls of buildings. When used for this purpose this type of bearing should be supported on cast-iron wall brackets; it does not need an adjustable baseplate.

Adjustable Ball-and-Socket Drop Hanger.—The fundamental purpose of the bearing known as a drop hanger is to support lineshafting. It can be used for lightly-loaded, short headshafts and any length of jack- or countershafting when it is necessary to hang these from above. It can also be utilized in an inverted position on the floor. This type has vertical adjustment through threaded plungers, and side adjustment through slotted holes in the base, but the bearing is free to adjust itself to the movements of the shaft.

The cast-iron, four-point suspension type equipped with self-oiling bearing is shown in Fig. 8. The bearing of this particular style of hanger can be adjusted both vertically and horizontally, but it is held more rigidly than in the ball-and-socket type. The ball-and-socket, cast-iron type is more generally used when the lineshaft is heavily loaded.

A four-point-suspension steel hanger equipped with self-oiling bearings is shown in Fig. 9. All of the hangers shown can be had in from 8- to 36-in. drop.

Heavy Headshaft Ball-and-Socket Drop Hanger.—In some instances it is necessary to hang heavy-duty headshafting from overhead steel work, instead of supporting it on substantial concrete piers or framing.

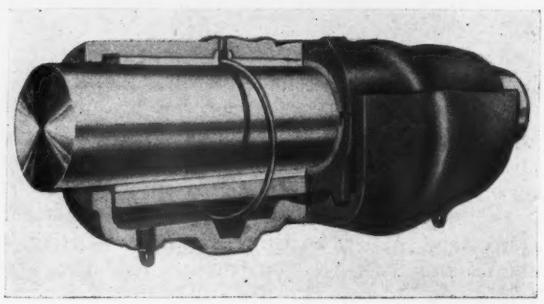


Fig. 14—Ring-oiling type of babbitted hanger bearing.

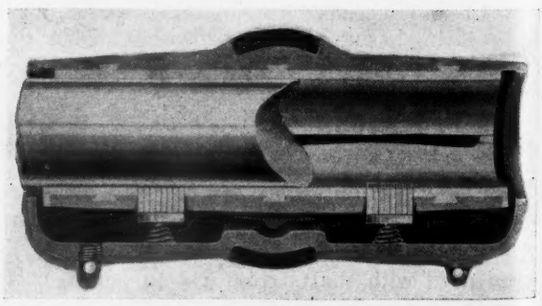


Fig. 15—A capillary-oiling type of babbitted hanger bearing.

For this purpose the short-drop, heavy hanger equipped with self-oiling bearings, shown in Fig. 10, should be employed. The bearing can be adjusted in a vertical plane.

Adjustable Ball-and-Socket Post Hanger.—This type of hanger is of cast iron and is designed for head- and lineshafting that must be supported from steel or wooden columns. It cannot be used against walls unless the pulleys or equipment on the shafting are of small diameter.

Adjustable Ball-and-Socket Wall Hanger.—This type of cast-iron hanger, Fig. 11, is designed to support light head- or lineshafting where a reach of 12 to 18 in. is necessary. It is of light construction and should not be employed for shafting above $2\frac{7}{16}$ in. in diameter. When shafting above $2\frac{7}{16}$ in. in diameter is necessary, use the cast-iron wall bracket equipped with ball-and-socket pillow blocks.

Cast-Iron Sling Hanger. — The sling hanger is an ideal support for line-, counter-, or jackshafting, subjected to heavy bending or vibratory stresses. Both horizontal and vertical adjustment of the rigid bearing are secured by the means of adjusting wedges.

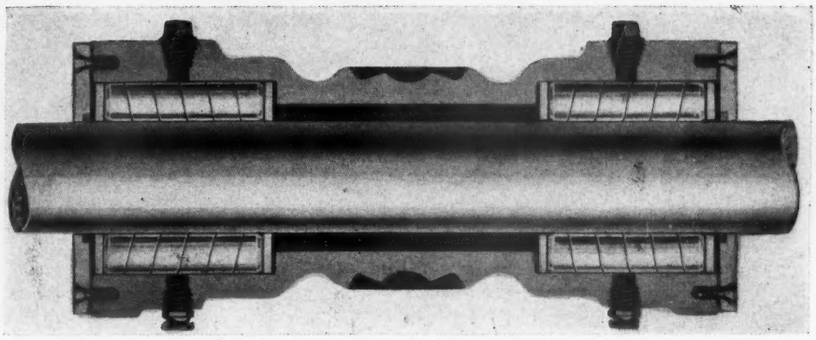


Fig. 19—Sectional view of a flexible steel roller hanger bearing.

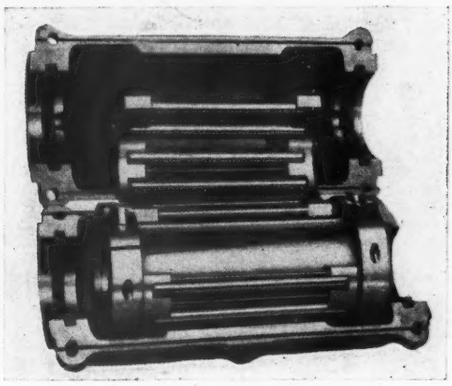


Fig. 20—Solid steel rollers carry the load in this type of hanger bearing.

The sling hanger is likewise a most satisfactory support for shafting connected by bevel or miter gears, as shown in Fig. 12. The regular ball-and-socket type drop hanger should not be used as a support for shafting adjacent to a gear connection.

Plain-Babbitted Hanger Bearing.—There are certain applications where lineshaft bearings are exposed to excessive dust and grit. For this service the type shown in Fig. 13 is generally employed. These bearings are tapped for grease cups, because this lubricant is better than oil for the service in which bearings of this character are used.

Ring-Oiling Babbitted Hanger Bearing.—This type of hanger bearing, Fig. 14, is universally employed for line-, jack-, and countershaft work, because it embodies a method of carrying oil to the bearing surfaces that is efficient and continuous. The rings are driven by their own weight on the shaft and pass through a reservoir of oil, carrying the lubricant to the top of the shaft. At speeds above 125 to 140 r.p.m., however, a churning action caused by the movement of the ring in the oil has a tendency to disturb accumulated sediment in the bottom of the reservoir.

Capillary-Oiling, Babbitted Hanger Bearing.—This type of hanger bearing, Fig. 15, is similar to the ring oiling box, except that it employs the principle of capillary attraction for carrying the oil to the point of need. The bearing is equipped with two soft wooden blocks provided with saw cuts through which only clean

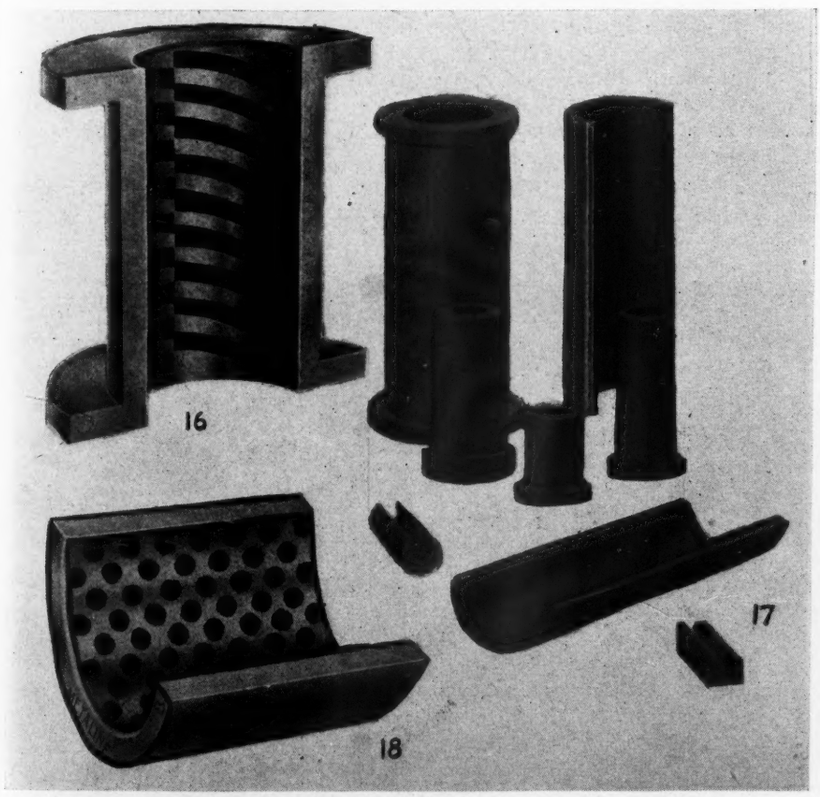
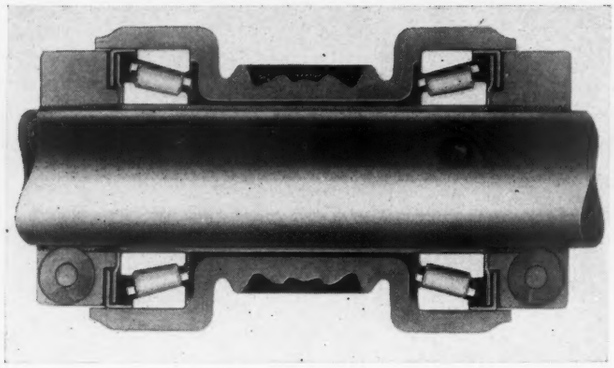


Fig. 16—In this bearing, lubrication is provided by graphite forced into the grooves in the bronze lining. Fig. 17—A type of hardwood, oilless bearing. Fig. 18—The metaline oilless bearing.



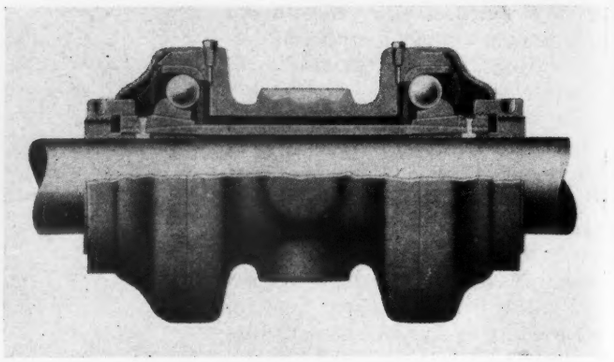


Fig. 21—(Left) The tapered steel roller hanger bearing looks like this. Fig. 22—A ball-bearing hanger box.

oil from the reservoir works upward to the shaft. It should be employed for speeds above 125 to 140 r.p.m., but it is not made for shafting above $3\frac{15}{16}$ in. in diameter.

Principles and Applications of Oilless Bearings

Oilless or self-lubricating bearings contain within themselves sufficient lubrication to assure continuous service even when neglected. There are several types on the market.

The Bronze and Graphite Type.—This type of oilless bearing, Fig. 16, is constructed of phosphor bronze containing symmetrical grooves varying in design according to the service for which the bushing or bearing is intended. These grooves are packed solid with a special, lubricating graphite. There is sufficient lubricant in each bushing or bearing to last as long as the bearing.

The Hardwood Lubricant-Impregnated Type.—This oilless bearing or bushing, shown in Fig. 17, dates back

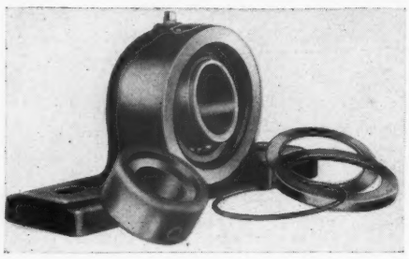


Fig. 23—Ball-bearing, ball-and-socket pillow block.

* * * *

to approximately the year 1701, when it was accidentally produced. It is made of hard, seasoned wood, thoroughly impregnated with a special lubricating compound that will outlast the bushing.

The Metaline Bearing.—This type of oilless bearing, Fig. 18, is constructed of either phosphor or gunmetal bronze into which are inserted $\frac{3}{16}$- to $\frac{5}{16}$-in. diameter metaline plugs. Metaline is composed of metallic oxides and other substances reduced to a powder and then solidified as small plugs in hardened steel molds. These plugs are inserted into flat-bottomed holes, drilled into the journal surface of the bearing.

The types of oilless bearings or bushings described have a wide field of usefulness in machinery of the textile and other industries, and in all manner of high-speed spindle work.

Applications of Antifriction Bearings

There are two distinct types of antifriction bearings—the ball and the roller—each possessing its own individual characteristics. The use of bearings of the types mentioned has become general in recent years and the results obtained have been of such a satisfactory nature that arguments to prove the economy of their use for all sorts of industrial operations can be eliminated.

The antifriction bearing is quite different from the plain or sleeve-

(Concluded on page 381)

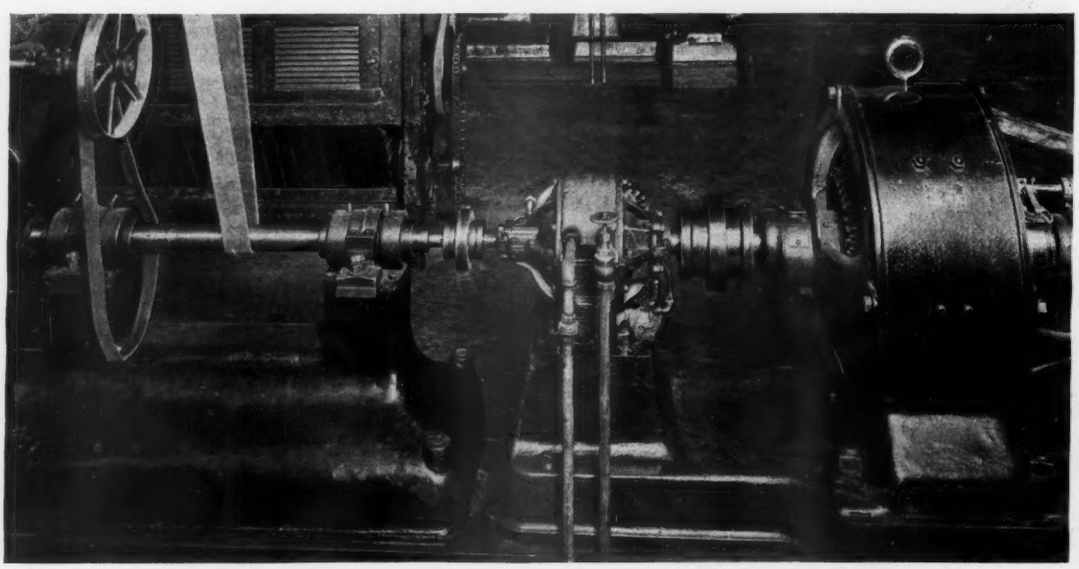


Fig. 24—One application of ball-bearing pillow blocks on a direct motor drive.

How to Determine WIRE SIZES *for* ELECTROMAGNETS

By H. B. BROOKS
Physicist, Bureau of Standards

IF carried out from first principles, the calculation of the size of wire for an electromagnet requires a knowledge of the magnetic properties of the iron used, and experience in estimating the effect of leakage flux, as this latter is not susceptible of exact calculation. For electromagnets to be produced in large numbers, the cost of the necessary expert development work is not a serious matter, but for individual jobs it is prohibitive. Also, it is often necessary to rewind an electromagnet for a voltage different from that for which it was originally intended. For such cases a rapid, accurate method is required which is simple enough as to equipment and calculation so that any intelligent mechanic can apply it. The following method is applicable to the case of electromagnets to be operated from a constant-voltage d.c. supply. It does not go into the question of the dimensions of the magnetic circuit, that is, it is assumed that the iron structure is already available and that the problem is to find the correct size of wire for a given supply voltage.

First, the bobbin should be wound full of any convenient size of magnet wire to serve as a trial winding. Although it is not necessary that the size of the wire of this trial winding be anywhere near that which is to form the final winding, it is well to choose for it a size which is probably near the final size, if it is available. If, however, the final winding is to be of fine wire and many turns, it may be inconvenient to use a fine size for the trial winding, and hence any convenient size may be used.

Connect the trial winding to any convenient constant-voltage d.c. source, using a rheostat to adjust the current through the winding and a voltmeter across the terminals of the winding. Regulate the current until by trial a value of this voltage is found which gives the proper functioning of the magnet. Neglect the question of heating for the present. By designating the observed value of voltage by e, the voltage for which the magnet is finally to be wound by E, the diameter (bare) of the wire in the trial winding by d, and the diameter (bare) of the wire with which the magnet must be wound by D, the following relation will obtain

$$D^2 = d^2 \times \frac{e}{E} \qquad (1)$$

That is, the area of cross section of the wire for the final winding in circular mils, which is equal to the square of the diameter in mils, equals the number of circular mils of the wire used in the trial winding multiplied by the quotient; trial voltage divided by final operating voltage.

Example: A given magnet was wound with a trial winding of No. 18 single-cotton-covered copper wire, diameter bare 40.3 mils, cross-sectional area 1624 circ. mils. By trial it was found to function properly for a voltage of 17 volts. It was desired to find the size wire with which it should be wound to function in the same way on 110 volts. Substituting the given values in the foregoing formula:

$$\text{circular mils} = D^2 = 1624 \times \frac{17}{110} = 251$$

This figure corresponds closely to the area of No. 26 American B. & S. gage, which is given as 254 circ. mils. If the magnet is rewound with No. 26 wire it will function on 110 volts in the same way as on 17 volts with the trial winding.

By using formula (1) to get D^2, and then extracting the square root, the diameter of the wire for the final winding may be obtained. However, since wire tables give the area in circular mils, this operation is usually unnecessary.

If the problem is to find the size of wire with which an existing electromagnet is to be rewound to function on a voltage different from that for which it was constructed, the winding already in place is, of course, used as the trial winding.

Thus far the question of heating of the windings by the current has been neglected. The following discussion explains how this is taken into account, and the influence of the thickness of the insulation and the regularity or irregularity of the winding on the result. First, assuming that by suitable cooling the winding may in all cases be kept at one definite temperature, the number of ampere-turns and hence the strength of the magnet when connected to a constant voltage will depend only on the size of the wire (bare) and not at all on the number of turns. (The proof of this statement is given in a later paragraph.) However, the amount of heat liberated per second is greater, the smaller the number of turns, and hence increased thickness of insulation and haphazard winding both tend to increase the heating. Aside from possible damage to the coil, if the heating be excessive, an increase of temperature increases the resistance and decreases the ampere-turns. It is therefore important to settle the question of heating at the start, by experiments on the magnet equipped with its trial winding.

The current which can be carried by a coil of magnet wire of given diameter depends not only on the size of the wire, but also upon the thickness of the insulating covering, the depth of the winding, the facilities for the escape of heat by conduction, radiation and convection, and the nature of the "duty cycle"; that is, whether the magnet is in the circuit occasionally or continually. For the cases under consideration, which do not justify much development expense, the simplest way to determine the question of heating is to wind the trial winding of magnet wire having normal thickness of insulation, pass a current through it and adjust it until the magnet functions properly, and then operate it on approximately the normal duty cycle until the temperature of the winding has become constant. If the heating is within these permissible limits, it will also be approximately within these limits with the final winding provided the latter is of wire having a space factor at least as high as that of the trial winding. The space factor of an insulated wire may

be defined as the quotient of the cross-sectional area of the copper divided by the area of a square which encloses the insulated wire. The value of the trial voltage e should be read while the winding is at maximum operating temperature, and the final size of wire calculated from it, as this will insure that the ampere-turns of the final winding will have the proper value when the winding is hot.

If the iron cores and other parts of the magnetic circuit have been chosen too small for the purpose, or if the reluctance of the air gap is excessive, there will be excessive heating of the trial winding, even though it is of wire having relatively thin insulation and is wound regularly. In such a case the remedy is to use iron parts of larger cross section, or to reduce the reluctance of the air gap, or both.

It will now be shown that for a wire of given material at a given temperature, wound in a given bobbin and connected to a constant-voltage source, the number of ampere-turns depends only on the diameter of the bare wire and not at all on the number of turns. It is assumed that in all cases the mean length of a turn is constant. If r is the resistance of one turn of the mean length of a given size of wire and assuming first that only one turn is used, the current taken from a source of constant voltage e is

$$i = e/r$$

Since there is only one turn, e/r is also the number of ampere-turns. Now increase the number of turns to n. The resistance increases to nr, but the ampere-turns equal n times e/nr or e/r as before. This solution shows that if we neglect the question of heating it makes no difference whether the insulation on the trial winding is thick or thin, or whether the winding is haphazard or regular.

How formula (1) is derived will now be shown. It has just been demonstrated that, regardless of the number of turns, the number of ampere-turns is equal to the current which will flow in a single turn of mean length. Having two copper wires of diameters d and D respectively, the resistances of a single, mean-length turn of each will be inversely as the squares of their diameters, and hence if each is to be operated on such a voltage as to make the number of ampere-turns equal in the two cases, the voltages must vary inversely as the squares of the diameters. The foregoing may be expressed either as a proportion such as

$$e : E :: D^2 : d^2$$

or preferably

$$e/E = D^2/d^2$$

from which

$$D^2 = d^2 \times \frac{e}{E}$$

It will usually happen that the cross section D^2 for the final winding, as given by formula (1), will fall between two consecutive gage numbers. If the final winding is the coarser of the two, it will have a greater magnetomotive force (larger value of ampere-turns) than the test winding had at the value e of test voltage. If the finer of the two adjacent sizes is used, the value of ampere-turns will be somewhat less. It therefore becomes desirable to be able to produce with the trial winding the two values of ampere-turns which are equal to those which will be produced by final windings of the two adjacent sizes of wire in order that an intelligent choice may be made.

Let the diameters of the two adjacent sizes in mils be D_1 and D_2, so that their areas in circular mils are D^2_1 and D^2_2 respectively. Two new values of voltage, e_1 and e_2, must be found which when applied to the trial winding will give the values of ampere-turns corresponding to final windings of wire of diameters D_1 and D_2. By setting these two new values of voltage on the test winding, one above, and one below the value e which gave the desired functioning of the magnet, it can be decided whether the smaller value of ampere-turns resulting from the use of the finer of the two sizes will be adequate, or if not, whether the increased value of ampere-turns and the increased heating with the coarser wire will be permissible.

From formula (1)

$$e = E \times \frac{d^2}{D^2}$$

or in words, the test voltage e to give the same ampere-turns with the trial winding of wire having an area of d^2 circular mils as will result from a final working voltage E applied to a winding of wire of D^2 circular mils area is equal to the final voltage E multiplied by the quotient of final circular mils divided by circular mils of trial winding. The use of this formula enables one to predetermine the effect of using any particular size of wire for the final winding. Giving D the values D_1 and D_2 corresponding to the two adjacent sizes of wire:

$$e_1 = E \times \frac{D^2_1}{d^2}$$

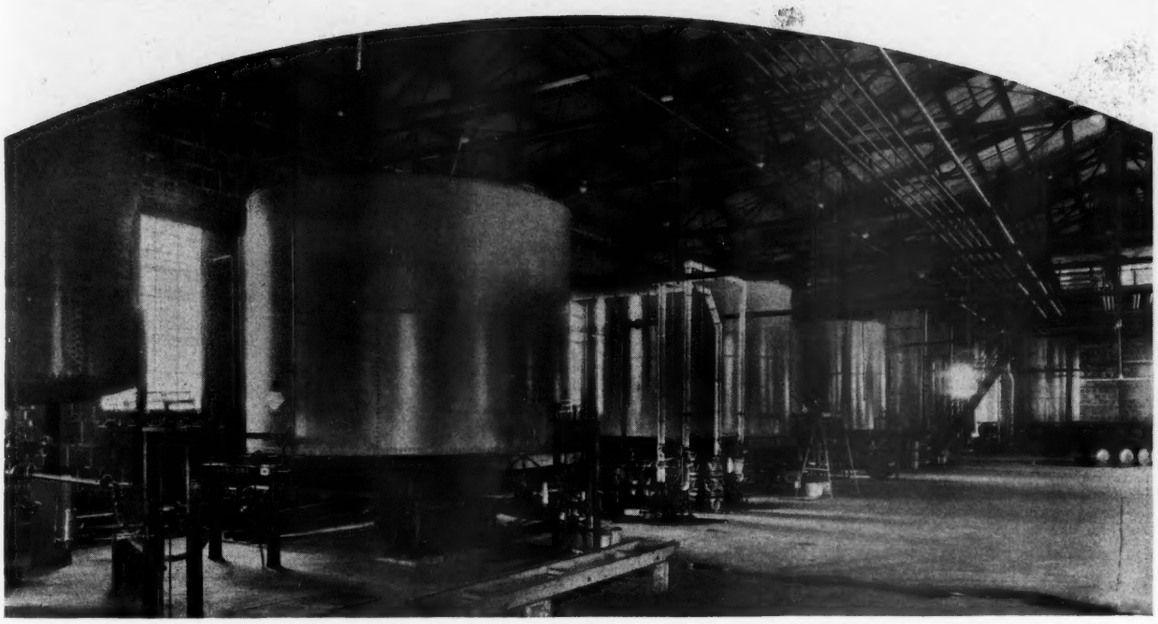
$$e_2 = E \times \frac{D^2_2}{d^2}$$

If the required number of ampere-turns is rather sharply limited, the effect of an intermediate size of wire can be realized by winding the magnet partly with the next size larger, and partly with the next size smaller wire. Although it is possible to derive a formula which will give the depth to which one size of wire should be wound before changing to the other size, it is sufficient for practical purposes to estimate the depth from a consideration of the differences between the value of circular mils computed by formula (1) and the values of circular mils of the two gage numbers between which the computed value falls. In any case it is preferable to err on the side of too large rather than too small a value of the ampere-turns in order to avoid failure of the magnet to operate properly at times when the supply voltage happens to be below normal. If it is important that the magnet shall function properly at some value of supply voltage less than normal, this lower value should be used as E. Heating at maximum voltage should then be considered.

MODERNIZATION

Is to be the theme of one of this year's issues of *Industrial Engineering*. There is a great opportunity for the service-to-production group to modernize electrical and mechanical equipment that is tributary to production. *Industrial Engineering* will show how this opportunity can be followed—in its issue of

OCTOBER, 1929



The tanks in the foreground are finished in gray. Those in the rear are finished in deep orange. Piping systems are completely identified.

The Place of Pyroxylin Finishes in MAINTENANCE PAINTING

By ROY C. SHEELER

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Prescription Paint Service
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NO one needs any special introduction to the so-called "lacquer" or pyroxylin finishes. They are being used both in spray and brush work, for all sorts and kinds of surfaces. This article, however, will deal with the pyroxylin finishes developed essentially for brush use.

What It Is

Pyroxylin finishes for brush application are based upon the same primary ingredients as the spray product with the difference only in the character of the solvents to permit of brush use. The spray product is impossible to apply by brush, since almost immediately upon application the surface is dry. The addition of gums and oils has been necessary in order to slow down the speed of drying and to impart the necessary qualities to permit of easy brushing.

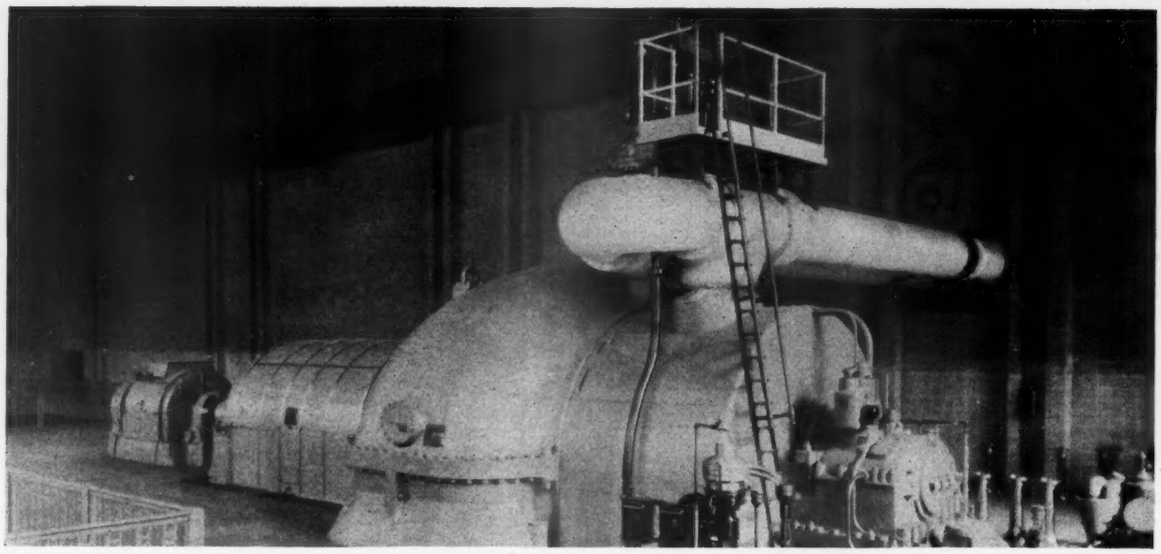
These finishes are in no sense to be considered as "cure-alls." They have their limitations just the same as all other finishes. Their widespread use in industry and the home has led to extravagant expectations. Due credit is given for their ability to do the unusual, but it should be understood that they cannot do the impossible, and that there are surfaces of plant and equipment on which even such remarkable finishes will not give satisfactory results.

What They Are Good For

For the most part the brush product should be used inside, with the possible exceptions of the darker colors. The blues, blacks, dark grays, browns, etc., may be applied to outside surfaces with satisfactory results. When used for exterior or interior work, the same preparation and condition of the surface are necessary as are required for the application of any other finish. In other words, the surface must be clean, dry, and free from oil and grease. These finishes have a particular antipathy for an oily surface. They positively will not dry if there is any particle of oil present. Where there is a suspicion of its existence, the surface should be scrubbed or washed thoroughly with gasoline or benzine.

Another important thing is to see that the previous finish, over which it is desired to apply the pyroxylin product, has not been too recently applied. The solvents present will fight with the oils in the previous finish, and may cause a lifting of parts of the finish, especially where it is heaviest. In other words, a previous finish should be perfectly hard and dry and have the oils thoroughly oxidized. One is generally safe in this respect if the surface has had from 60 to 90 days in which to dry.

There are, of course, some exceptions, the most important of which is that a surface finished with a mahogany stain of an aniline nature is apt to bleed through. If there is any likelihood of bleeding, it will show itself almost immediately after application. The solvents in pyroxylin finishes are exceedingly penetrating in character, and have an affinity for aniline dyes, especially those of the mahogany family. Where such conditions exist they may be overcome in many cases by repeated applications,



An application where the paint is subjected to heat and to lubricants. Turbines and railings are finished with brush gray.

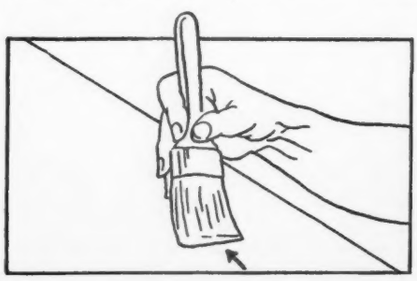
eventually hiding the red stain that persists in coming to the surface with sheer weight of the product.

Another important point is the difficulty frequently experienced where the previous finish has been removed with one of the waxy types of paint and varnish removers. The wax is used in these products to prevent a too rapid evaporation of the ingredients that accomplish the softening of the film. If such a remover is used the surface must be scrubbed with benzine or gasoline, not once, but probably many times, in order to remove every least bit of wax from the pores of the wood. Either open or close-grained wood will absorb more or less wax and unless this is completely removed the subsequent finish will be exceedingly slow in drying or probably never dry at all.

If one should be so unfortunate as to fail to do this washing thoroughly, the only thing to do after the new finish is applied is to wash the surface with gasoline until it is dry again. Then follow with another coat, and if it fails to dry, wash again with gasoline. Repeat these operations until the desired result is obtained.

If new or unfinished metal surfaces are to be covered with a pyroxylin finish, it must be remembered that in most cases the new finish will not adhere properly unless it is preceded with a certain type of undercoat or primer. This primer is usually a flat-drying type made especially to act as an intermediate finish between the product to be painted and the finishing coat. Of course, the metal must be clean, free from mill scale, rust, dust, dirt, etc. Lubricating oil or grease must not be present in the slightest degree, else trouble will be experienced in the drying of the film.

The feature that makes the pyroxylin finish desirable is its quickness in drying. This is especially important in many industries where there is a limited amount of time available in which to refinish a surface. Although the finish will



The secret of the finish is in the application. For covering flat surfaces the brush should be held as shown, brushing out only enough to produce an even coating.

* * * *

usually set in from 15 to 30 min., a second coat should not be applied for at least two hours after the first. This procedure will give a sufficient length of time for the film to harden and it is not likely to be picked up with the new coat.

If new or unfinished wood surfaces are to be finished with pyroxylin, they should receive one or more coats of a similar type of undercoat. Such undercoats have been developed in a number of shades that are suitable for almost any color, and which possess some of the same characteristics as to drying time, working qualities, etc. These coats when dry present ideal surfaces upon which the finishing coats may be applied.

There is a secret in the application of these finishes, which to the uninitiated seems to be difficult to grasp. It is this: "Do not attempt to draw the brush again over a surface just painted." This action will accomplish one of two things: either a complete spoiling of the job, or a partial removal of the finish, just applied.

The solvents in these finishes are very powerful and quick-acting. They have the ability to amalgamate with the previous finish and become a part of it. In this respect they are entirely different from paint or enamel, which are entirely independent of previous coats and simply lie upon them. When two or more coats of pyroxylin finish are applied, they unite with one another and really become one coat. For this reason, draw the brush over the surface but once, and when it starts to lose its hiding power, dip the brush again into the can and proceed.

Where Pyroxylin Finishes May Be Used

Their great field in maintenance work lies in plant equipment. Here, their wonderful durability, smooth surface, and quick drying and attractive finish fit in well with the general requirements. From the standpoint of exterior usefulness, among the surfaces that may be so finished, are the following:

Fire plugs, hydrants, valves, alarm boxes, carts. In these applications

their brilliant colors, ease of application, and smooth finish make their use very desirable.

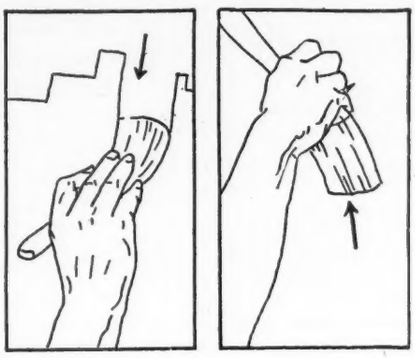
Pipe lines. Color systems in industrial plants call for shades that are easily discernible. For piping identification, therefore, pyroxylin finishes are unusually acceptable.

Factory trucks and cars. The darker shades are suitable for this work and are unusually durable. Ease and quickness of refinishing is also an important consideration here. A nationally-known company, using large fleets of trucks which it keeps in a spic-and-span condition, and which are finished by hand, has adopted this type of finish as standard. The workmen like to handle it and the resultant finish in the colors used is long-wearing.

The possibilities as interior finishes are much broader. They are essentially designed for inside use and for that reason their field here is large. Check over the suggestions that follow:

1. Floors. Wood or concrete may be finished with satisfactory results. Such finishes are unusually resistant to abrasion as well as to contact with moisture. Their smooth, even finish permits them to be easily cleaned. Manufacturing operations are frequently hard upon average floor finishes, and for these the pyroxylin types are often found far more satisfactory than anything else.

2. Doors, trim, baseboards, dados. Applied after working hours, the quick-drying, smooth finish makes possible a complete new dress for such surfaces of offices and similar surfaces, with the opening of the office at the usual time the next morning, if necessary. For instance, a conglomeration of golden oak, dark oak, and various other pieces of office equipment may be "made over" over night. The next morning an attractive, uniform finish is ready for use. Touch-up work on such finishes can be done quickly, blending in with the surrounding finish without being noticed. A plant in the East was more than pleased with the result after trying out the idea in a limited way. A pleasing shade of dark green was used on desks, chairs and filing cabinets, changing the appearance completely.



These drawings illustrate the proper down and up strokes. Remember to keep the brush at an angle as shown.

* * * *

3. Machinery and similar equipment. One of the largest fields of usefulness is on such surfaces. A far better and more durable finish is possible with pyroxylin finishes than with those of almost any other type. One of the important questions that must be answered is its resistance to heat. In most cases such finishes will stand up longer under constant heat than other finishes. It must not be expected, however, that where the heat rises above 400 deg. F. such finishes or any other kind will stand up very long. Their main usefulness here lies in their ability to withstand contact with the peculiarities of manufacturing processes which are frequently detrimental to most other finishes.

4. Racks and bins, filing cases. Quick drying and resistance to abrasion are again the high points of usefulness here.

5. Piping systems, fire equipment, waste cans, drinking water tanks, and similar surfaces, where strong, brilliant colors are desired, may be so finished with splendid results.

Using the information given here, no plant engineer should have difficulty in checking up the possibilities of pyroxylin finishes in his maintenance program. There are a number of good makes on the market from which to choose, some possessing features of improvement and advancement over others. He should soon be able, however, to determine the one best brand for his use, and if he carefully follows directions for the preparation of the surface and takes a little time to become familiar with the best methods of application, he should have no difficulty in making good use of this type of paint. Nevertheless, he should try to be reasonable in his expectations. Such finishes should not be expected to do the impossible. They are remarkable and unusual, it is true, but like everything else, they have their limitations.

Pieces of office equipment may be "made-over" over night as was done in this case.

Are You Ready for the Question?

Should the Plant Engineering Department Have the Right to Question Orders?

Here is the first of a series of questions, each of which has at least two sides. A new question will be presented next month, and our readers' answers to this month's question also will be published. Write down your opinions and send them to the editor. Incidentally, answers published will be paid for.

You will remember that in the May issue, Frank Fulleger, a young plant engineer, and George Shipman, a works manager, were interrupted in the midst of a serious discussion concerning how much maintenance work should be done within the plant and how much sent to contract shops. Shipman's wife caused the interruption by calling for her husband at the club where the two men were talking.

The discussion will not be resumed by Fulleger and Shipman, but further remarks are available, nevertheless. Readers of INDUSTRIAL ENGINEERING *have submitted discussion, some of which is published on the two following pages. In the meantime, the two men have again come together at the club and are concerned with another problem as they cloud the air with smoke from their pipes.*

"I see that I have a lot to learn, George," said Frank Fulleger, "but I guess I'm not the only one."

George Shipman interrupted to pass on an indirect compliment: "Perhaps that's why you have the job, Frank. Half the battle is in feeling that you don't know it all. But what in particular is bothering you now?"

"Just this: I've about reached the point where I ask the works manager for authority to question orders to my department. I don't see how I'm to live down to a budget with all the moving that's going on."

"I judge that moving is charged to maintenance in your plant, Frank."

"Yes, it is—I don't think that's necessarily right, but I can't help it just now."

"Isn't all the moving that's done necessary?"

"By and large, it is, George. Oh, I suppose some of it could be dispensed with, but not enough to squabble about. What I think is that my department ought to be consulted more as to the details of moves. It isn't a matter of pride with me, but of saving money."

"And how would you do that?"

"Well, suppose Smith has to add four machines to his department. In our crowded fix it means jam up what he has to make room for them, or get some room from another department. If he jams up, there are matters of location for foundations, or beams, or feeders, or lights to be considered. If he spreads out, several departments may be affected, with the same problems in each one."

"Anything else, Frank?"

"Yes—water lines, gas lines, and sometimes oil lines have to be considered. Once in a while somebody will overlook placing a machine conveniently for crane service, or truck service, or won't allow room for parts in process. Oh, yes, there are quite a few things to consider, George."

"And the department heads now have the responsibility for moving specifications?"

"Yes. Some of them do a mighty fine job, too. But others overlook plenty. In many cases I could save a lot of time and money; but I'll have to get the idea over with the W. M. first."

"You know, Frank, I have an idea that's one of the things the W. M. expects from you. I know Bill Williams, and I have a hunch he's not exactly satisfied with past procedure. Put it up to him, son, and see what he says."

* * * *

Frank and George have disclosed a worthy subject, and between them they have made out a case for Frank. But they haven't covered the subject by any means. There must be hundreds of instances where consultation with the plant engineering department would have saved much trouble and expense in moving.

Tell the other readers of INDUSTRIAL ENGINEERING *about your moving troubles. Your letter should reach the editor by August 1 for August publication. As a guide, consider the following questions:*

Who should have the final say-so on moving?

Should the plant engineer, master mechanic, millwright, or whoever has to direct the actual moving, have the right to question moving orders?

What are the important details that have to be considered in moving and relocating equipment?

and here are answers to the question

"What Shall Be the Maintenance Policy"

THE question of what is the best maintenance policy is one that is difficult to answer. Its proper answer depends upon many variables. Among them, as perhaps the most important, are:

1. What is the proper standard of maintenance, and
2. Shall the work be done by home organization entirely; contracted for entirely; or in part by each method.

It is generally agreed that it is economical to keep plant and equipment maintained to a relatively high standard.

As part of the organization of smaller industries we frequently find the maintenance department consists of a so called "handy man" who is supposed to be kept continuously busy doing "odd jobs"—one day, for instance, he may be fixing a leak in a down spout; another, extending an electric circuit, or installing a new radiator valve.

As industry has grown in size the necessary maintenance work has grown in quantity and in place of the "handy man" we now find organized crews of electricians, plumbers, steam fitters, carpenters, painters, etc. It is obvious in the case of the "handy man" that if he gives honestly of his time and effort and is reasonably efficient, he can do these ordinary jobs of maintenance work much more cheaply than can be done by the local contractor who makes his charges on a basis of f. o. b. his shop.

For the same reason it may properly be assumed that similar work, on a larger scale, can be most efficiently and economically handled by the plant crew. In case of the larger organization, proper supervision must take the place of personal interest, honesty of purpose, and loyalty to his superiors that generally existed in the case of the "handy man."

It is when the somewhat unusual jobs are to be handled that there comes the necessity for real thought as to the best method to follow. In a large plant there are cases where the job is entirely too big to be handled by the ordinary plant crew within the allowed time. It becomes necessary then to put on a temporary crew; enter into a contract for the work on a flat price; or secure the necessary men from an outside contractor on a cost-plus basis. In the third case regular hourly rates plus a percentage for overhead and profit is commonly used.

The first method, building up a temporary organization, is perhaps the best to follow where the work to be done is so tied into other work

that it is not easily possible to write specifications covering it. A typical case of this kind would be the installation of new equipment where a great deal of moving, building changes, etc., were necessary. The extra crew would operate as an addition to the regular plant force and should get careful and interested supervision. There should also be an advantage in cost and efficiency because it would not be necessary to draw such a strict line in the matter of class of work to be done by individuals as if outside tradesmen were employed.

Wherever the work to be done is of considerable magnitude and can be clearly outlined and specified it is, in general, economical and to the best interests of the industry to employ an outside contractor, selecting one, of course, who is well equipped to do the particular job. This avoids the necessity of organizing a temporary crew and the sometimes attendant difficulty of disbanding it promptly.

Insofar as ordinary maintenance work is concerned, we should expect to find better standards of maintenance where the work is handled, at least in large part, within the organization. This method should tend to the elimination of expensive deferred maintenance even though at times there might be a little too much initiative in the way of hunting or creating work. In the matter of installation of equipment, the same general rule should hold, although the ease with which it is possible to purchase equipment "delivered and installed" sometimes makes for excessive costs that are entirely covered up for the time.

It is quite convenient to regard maintenance work as a necessary evil and to give it little or no supervision. It is obvious that maintenance work to be efficiently and economically done should have the same sort of supervision as to payroll and personnel that is given in case of what is usually termed productive labor.

Maintenance is not a necessary evil, but is a very definite necessity. This is true not only in industry but in the case of the homes in which we live, the streets and highways on which we drive and the railroads on which we travel.

In general, the following seems to be a sound and efficient method of handling this work:

1. Organize within the plant to handle ordinary and routine maintenance work, but be sure it has proper supervision.
2. The unusual and larger tasks to be handled by outside forces.

—T. A. KEEFER, *Head Factory Layout Dept.*
National Cash Register Company
Dayton, Ohio

EVERY plant draws the line somewhere. The more isolated the plant, the more maintenance work it must be equipped to do. Such a problem must be considered in connection with location, size of plant, factory, practices as to storage of finished product, and a half dozen other points peculiar to the industry in question.

Of course the whole matter resolves itself to a cost comparison in the last analysis. For some items such a comparison is easy, say repair of tar and gravel roofs in large plants. For some items such comparisons are difficult because the imponderables outweigh direct material and labor cost.

Consider, for example, armature winding. Unless there is enough work to keep at least one winder and helper busy, it is generally cheaper to send D.C. armatures and A.C. stators in the partially closed slot sizes out for winding. The result is that the shop electrical department has no coil puller, no taping machine, and only a small stock of magnet wire in a few sizes.

If the resultant delay in extreme emergency cases paralyses production, even stops the assembly line a time or two, we must include the cost of these manufacturing delays in the balance to arrive at a rational cost comparison. Yet who can estimate such factors with any degree of accuracy? It is in such cases that good repair records of the past are very helpful.

—ROBERT W. DRAKE, *Consulting Engineer*
International Harvester Company
McCormick Works, Chicago, Illinois.

IN my opinion the amount of maintenance work to be done within the plant depends on the location of the plant and to a certain extent the type of equipment used. My experience has been mainly in plants situated in the desert and outlying places, where time is the element to be considered. Work done outside must be shipped by rail, in many cases accompanied by some one to superintend it. This situation requires that we do it ourselves. Under different circumstances it would, unquestionably, be done cheaper in a contract or repair shop.

For a shop having access to all the necessary trades, I think that all except minor "running" maintenance should be done at a contract rate, either with individual firms or a firm of maintenance engineers. In this service the contractors make periodical inspections, carrying out such minor repairs as the contract calls for. Major work is done on a cost-plus, or in the case of big work such as rebuilding boilers, replacing complete elevators, etc., on a contract basis. Painting is also done on this basis. Attention to lights

is taken as part of the service, with parts on a cost-plus basis.

When maintenance work will overtax and disorganize the maintenance department, or is of a type requiring specialists, all of it should be let to contract shops.

Should there be a limit on the amount of the order that the maintenance department may place? Yes. The head of the department should have a free hand on expenditures up to a given figure. Over this it is good practice to give an estimate of the work to be done with fullest details as to why, when last renewed, etc., to the management for the approval, which may be in the nature of a work order signed by the manager.

Yes, the management should take the plant engineer into confidence as to why a new policy is adopted. The plant engineer would not necessarily have to spend any time explaining in detail to his men the whys and wherefores of the management's policy. I assume the position "plant engineer" is responsible enough for the management to regard him as capable of seeing the point of view and organizing his work in such shape as to conform with policy.

I am of the opinion that in many cases it costs more to contract the work out, on account of the overhead having to be absorbed by the shop, not being split into narrow units as in the "home-done work."

—MAURICE C. COCKSHOTT,
Mechanical Engineer
Hancock Oil Co., Long Beach, Calif.

WHERE no satisfactory connection can be made with a contract shop, it may be desirable to do all the maintenance work within the plant. Such a decision can be made only after making a thorough survey of maintenance costs, both within and outside for purposes of comparison, where lie the advantages in delivery, accuracy, and so on.

Only under exceptional cases should all maintenance work be done on the outside, for instance if a contract shop is very close and an agreement can be reached whereby it will do all of your work in preference to others in case of emergencies. Even in such cases this would be justified only in the case of the smaller plants.

I believe the most satisfactory method is to split the maintenance work. The work that should be let out is whatever cannot be delivered in a reasonable time by the crew ordinarily on hand, also jobs requiring special machine work for which the plant shop is not equipped.

As to whether or not it costs more to get work done in contract shops depends upon a number of conditions. First, of course, is what kind of connection can be made. Such things as hourly charge, the delivery that can be made, etc., must be considered. I really believe that such work as rebuilding machinery, making up stock parts, or making new machinery can be more profitably handled by letting it out on contract.

Second, if enough men are maintained on the regular maintenance crew to do this work there are times when the expense reflects itself on the cost of maintenance.

Third, because it diverts the attention of the maintenance crew from the regular line of work.

In emergency cases the maintenance department should not be limited as to the amount of work to place on the outside, since the objective is to get it the quickest way possible. In other cases, while they should be limited as to the size of work they undertake without approval, we believe that after a job is decided upon it should be left to the maintenance department as to where it should be done.

In answer to your question as to whether unnecessary work is done by the maintenance department just because the men are available, I say, "Yes, there is." Abundance invites waste and it is a fact that when men are available maintenance work that is not absolutely necessary is done. We have found that there is also a tendency on the part of the department foremen to be more lax when they know there are a number of men on hand to take care of them.

I believe that Frank could have proceeded much more intelligently had he known why the curtailment order was issued. It would have put him in a position of knowing what he was doing, and thus have made it much easier to explain to the men, as he could have talked more to the point.

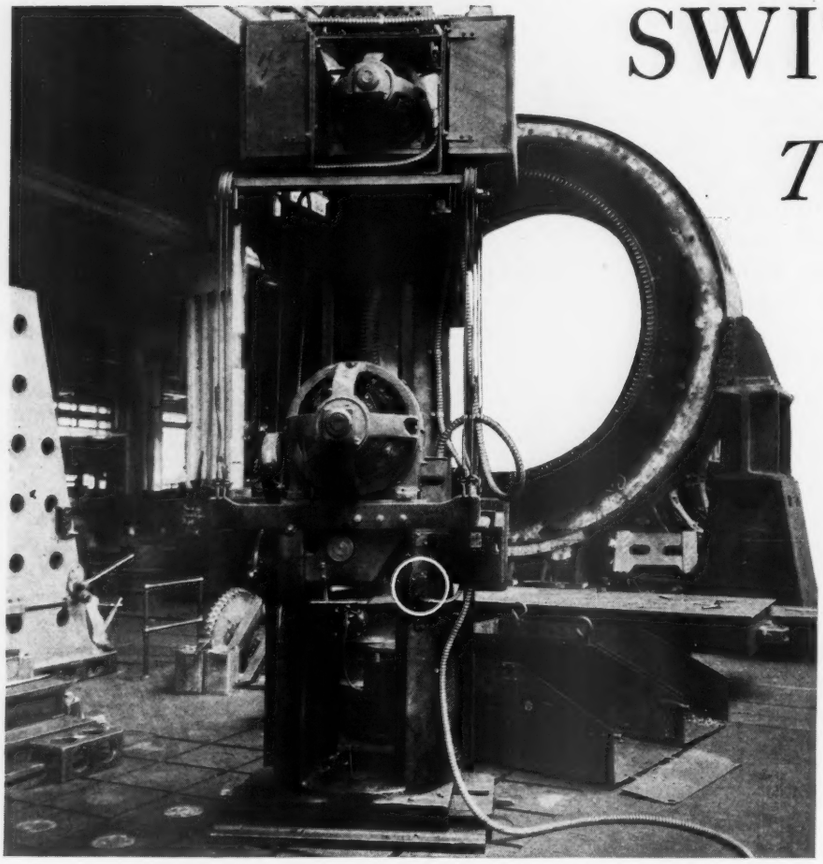
The above are our answers to your questions, and are based more or less on the experience we have had in our maintenance department. Just recently we, also, issued a curtailment order and have since found that our maintenance cost has gone down. The work the maintenance department cannot handle is placed on the outside very satisfactorily. In a few words, we have converted our maintenance policy from a corrective one to one of prevention.

—WALTER C. GEORGE, *Chief Engineer*
Robert Gaylord, Inc., St. Louis, Mo.

ELECTRIC LIMIT SWITCHES—

Their Care and Use

By J. A. JACKSON
Industrial Engineering Department
General Electric Company
Schenectady, N. Y.



The limit switch bears no relation to the size of the machine it controls. One of the smallest limit switches made is used on this portable milling and drilling machine. It is indicated by the white circle on the frame.

THE NAME "limit switch" implies that it is a device which must be extremely reliable in its operation and hence should be given the best of maintenance. If its duty is to limit the operation of some piece of machinery, it stands to reason that at least one object for using it is, that more or less damage or trouble will occur if the operation proceeds past the point at which the limit switch is set to act. The best of maintenance is, therefore, none too good, for no matter how well designed and built, a piece of apparatus will not run indefinitely without normal wear and tear, which in the case of a limit switch may destroy the accuracy of its setting and thus impair its usefulness. A limit switch is so designed and used that at the proper time or location in a cycle of duty on the controlled machine, it will automatically make or break one or more electric circuits and thus start, stop, accelerate or decelerate one or more motors driving the controlled machine. Its correct functioning must be entirely independent of any action on the part of the man operating the machine. In fact, limit switches are largely used to obtain complete automatic operation of machines and thus reduce labor to a minimum.

Types of Switches

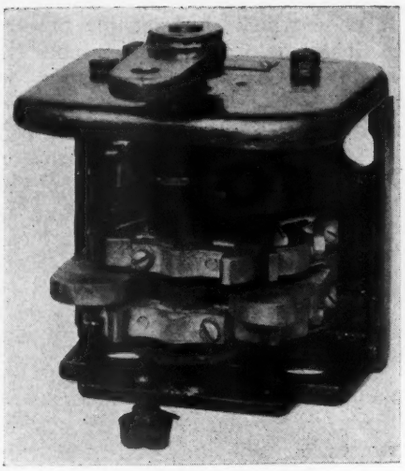
Of necessity, limit switches must be built in many types and forms on account of the large variety of uses to which they are put, and the many different kinds of machines which they must control. In general, they may be divided into two types, track type and geared type, depending on how the switch mechanism is operated by the controlled machine. Both types are built in many different forms. The track switch is the simplest type and in its most common form, the electric contacts are made and broken by the movement of a lever, often of a special shape, which projects from the side or end of the switch. The lever shaft may carry part of the electric contacts clamped to it or it may carry one or more cams which actuate the electric contacts. The geared limit switch is connected to the controlled machine by a positive drive such as gearing or sprocket chain and its shaft rotates all the time the machine is in operation. The interior mechanism of the switch is so designed that electric contacts are made or broken at definite, but adjustable points in the cycle of operation. The mechanism for accomplishing this may consist of adjustable rotating cams which actuate the contacts, horizontal moving cams on a traveling nut which trip electric contacts, projections or dogs on rotating cylinders which trip electric switches, rotating metal segments which make and break contact with a series of stationary fingers and so on.

One of the smallest track-type switches made, measuring approximately 1⅞x2¾x4⅜ in. overall is shown mounted on a portable milling and drilling machine. It is arranged to handle a single circuit with a double break and is made with either normally-open or normally-closed contacts. Although small, it can be used on fairly hard service where compactness is essential. The shaft must be moved through 9 deg. to open or close the contacts. It is spring returned to its normal position. A somewhat larger track-type switch is also shown. This form is

known as a hatchway switch as it is largely used in elevator hatchways. It can handle either one circuit with two breaks in series or two circuits with a single break in each circuit and is made with either normally-closed or normally-open contacts. A ¾-in. depression of the roller opens the contacts and a spring returns the arm when the roller is released. A still heavier track-type switch for use on heavy-duty equipment such as in steel mills and on car dumpers and similar heavy machinery is shown in an accompanying illustration. It can handle either one or two circuits with normally-open or normally-closed contacts. The form shown handles one circuit with two breaks in series. The lever throw is 70 deg. for full operation.

All of these switches are operated by some form of lever, the shape depending upon the application. The lever makes only a small part of a revolution for a complete throw of the switch. These switches are usually made with a spring return making it necessary to hold the lever by external means when moved from its normal position, although some forms have star wheels that hold the switch in either position to which it is thrown without maintaining external force on the lever.

There is a simple type of traveling nut geared limit switch in which a nut held from rotating travels along a threaded shaft as the shaft is rotated by the controlled machine. The nut has pins which strike electrical contact arms opening or closing them at certain points during its travel. These points are adjustable by changing the position of the contacts or by changing the length of the striking pins. This is a simple, light-duty switch which handles two circuits in each direction of travel. It is not sufficiently accurate for use where the controlled car or machine travels a long distance, as the gear reduction then becomes very great causing the nut to travel very slowly. This slowness of travel causes the electric contacts to break gradually thus drawing an arc and, in addition, the large gear reduction magnifies all errors.

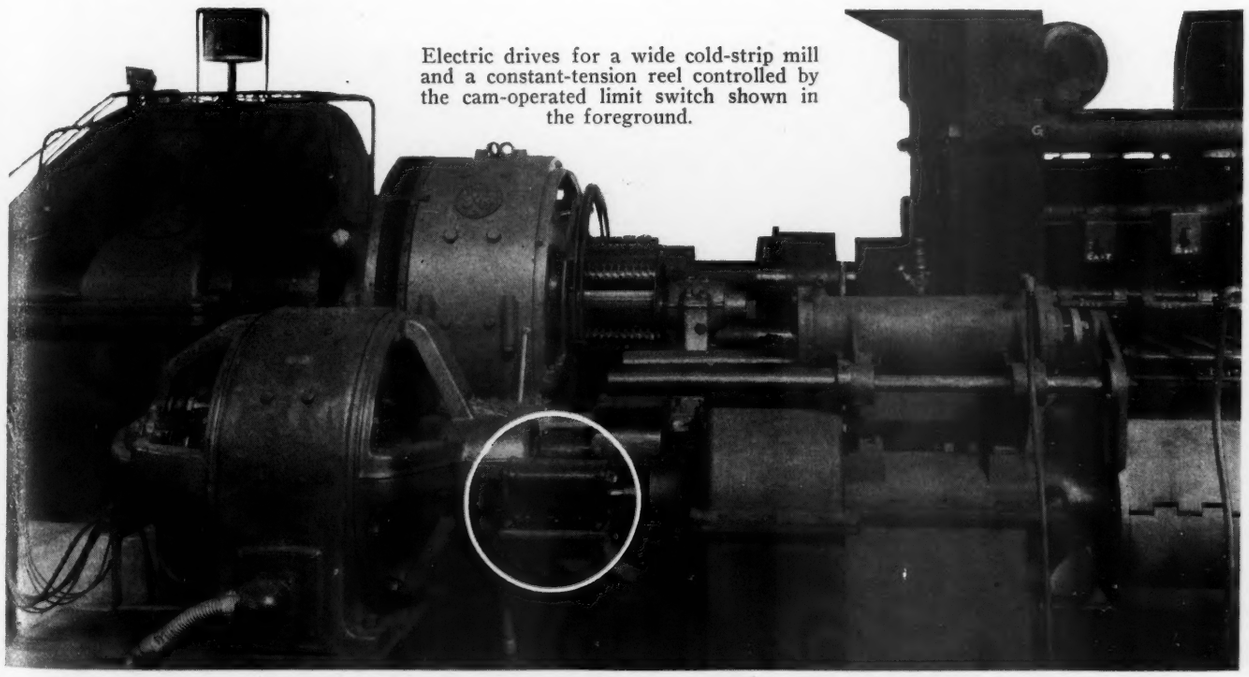


One circuit with two breaks in series can be handled with this heavy-duty, track-type switch. The lever throw is 70 deg. for full operation.

* * * *

In one of the small geared switches of the cam type, the worm gear shaft carries two adjustable cams which operate two electric contacts. Coarse adjustments are made by changing the position of the cams while fine adjustments are made by changing the position of the contacts by means of the knurled-head screws, which may be seen by referring to the illustration. Two circuits only are handled and they are usually wired to give a stop in each direction of travel.

A very flexible switch of the cam type designed to handle six circuits, is also shown, each with two breaks in series and each of which can be made either normally open or normally closed depending upon the setting of the adjustable cams. Each molded cam wheel carries two adjustable cams or dogs, one for making the electric contacts and the other for breaking them. As the shaft rotates these dogs cause the contacts to open and close, the sequence of operation of the contacts depending upon the location of the various dogs. The design is such that either dog can be located at any point around the circumference of the wheel thus providing great flexibility and accuracy in adjustment. The circuits are always interrupted with a snap action which insures accuracy and prevents burning. The switch is adapted for continuous rotation either clockwise or counter-clockwise or it may be used on reversing service. An inclosed gear reduction can be mounted at the end of the switch when applied on ap-



Electric drives for a wide cold-strip mill and a constant-tension reel controlled by the cam-operated limit switch shown in the foreground.

plications where a long travel must be taken care of.

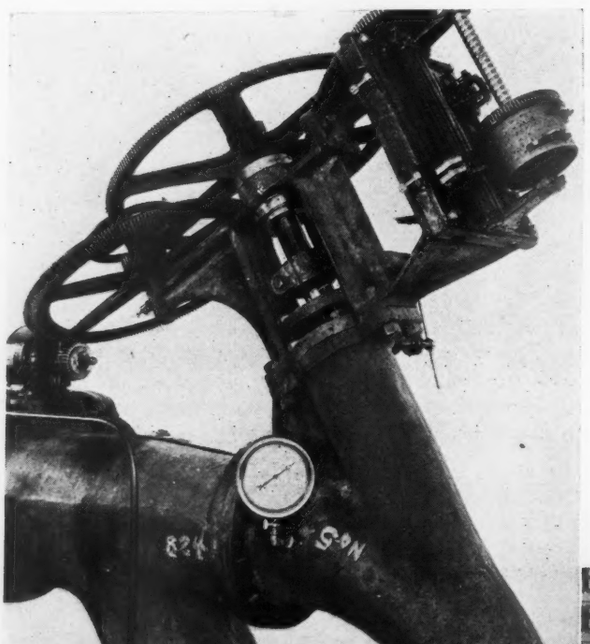
Mounting and Operation

Track switches may be mounted on the controlled machine or on some stationary structure by which the machine passes depending on which fits in best with the scheme of control in use. If the control equipment is carried on the moving machine, extra trolleys are avoided by mounting the switch on the machine, but if the control is not carried on the moving machine, simpler wiring is obtained by mounting the switch stationary and tripping it from arms on the moving machine.

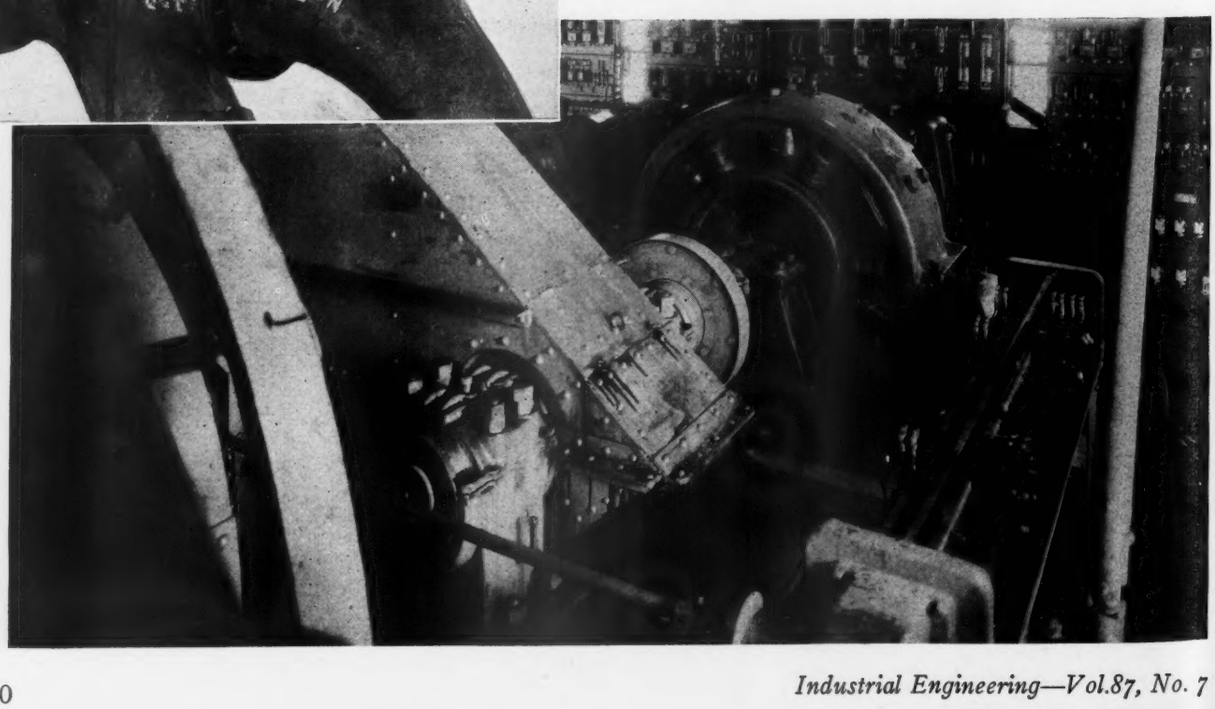
If mounted on the moving machine the switch arm is tripped by one or more stationary arms or dogs mounted on some stationary structure by which the machine passes. Adjustment of the tripping point is made by changing the location or shape of the arm or dog. If the switch is stationary its arm is tripped by one or more stationary arms or dogs on the moving machine and the adjustment of the tripping point is usually made by changing the location of the switch. With the latter method of mounting, two or more switches are often necessary if several electric circuits are to be handled, although with the former method one switch can sometimes be made to handle several circuits in succession with independent adjustment of each circuit, particularly if the electric contacts are made and broken by cams.

Track-type switches are used on such applications as bridge motions of cranes and ore bridges, skewing motion of ore bridges, elevators, planer beds, door operating machinery, larry or transfer cars operating on fixed lengths of track, crane hoists and on any motion where the stopping point must be accurately located regardless of changes in cable length due to stretch or temperature change. They are frequently used as an auxiliary to a geared-type limit switch to give an emergency stop if the geared switch fails to make the normal stop.

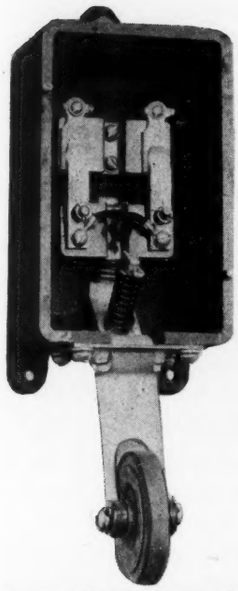
Geared switches, as their name implies, are geared or chain driven from some shaft of the machine they control. The conditions they must meet vary so widely that many types and forms are necessary to cover the field. For example, there is the reversible type as used on skip hoists which slows down and stops the skip at each end of travel. The reversible type must also be used on mine hoists but here the distance the hoist travels is so much greater than the travel of the ordinary skip hoist that a different mechanical arrangement of the switch is necessary to get the required accuracy. Then, there is the continuous rotating type as used on some steel mill machinery. This switch never reverses but it must make and break a number of contacts in a definite sequence which



Geared-type limit switch (cover removed) used to control needle valves of the water turbine which drives a 500-kva. remotely-controlled generator.

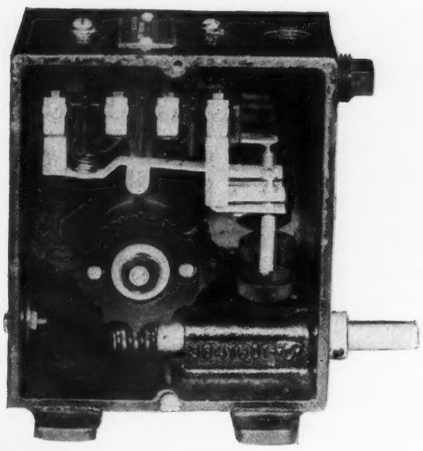


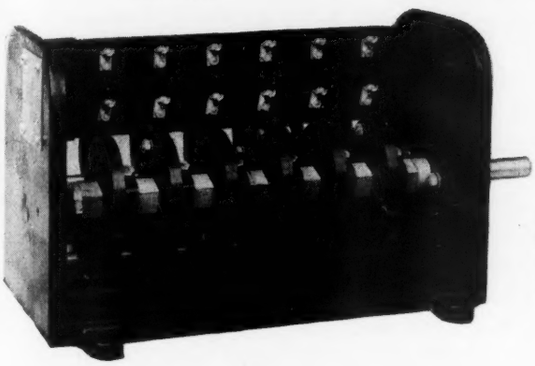
Inspection and adjustment are simple problems if the equipment is accessible. An installation of a limit switch geared through a differential to both cradle-hoist and girder-screw motions of a 120-ton lifting car dumper.



A track-type limit switch often referred to as a hatchway switch for elevators.

Coarse adjustments in the small geared switches of the cam type are made by changing the cam position. Five adjustments are made by changing the position of the contacts. The knurled-head screws accomplish the latter.





A switch of the cam type adopted for continuous rotation either clockwise or counterclockwise or for reversing service.

sequence must be continually repeated. Reversible-type limit switches as used on the cradle motion of car dumpers must be arranged to give a slowdown and stop at each end of travel, and they must also have contacts to give a slowdown and an acceleration at some intermediate point, which point must be adjustable with respect to the stop at one end while maintaining a fixed distance from the stop at the other end. This condition requires a somewhat complicated mechanical drive. Geared switches are also used for obtaining the correct sequence of operation between different machines or parts of the same machine where separate motors are used to drive the different machines or parts. Good examples of this are the blast furnace skip operating in sequence with the large and small bells on the furnace top, and the grain car unloader which has complete limit switch interlocking to compel correct sequence of operation. Many other applications could be cited but those mentioned will serve to show the difficulty of designing a geared limit switch which will be universally applicable.

Selection of Limit Switches

A knowledge of the machine to be controlled and its sequency of operations will usually determine quite readily whether a track-type or a geared-type switch can best be used. Next, the proper cover must be considered. Covers are usually made reasonably dust tight, but for very dusty locations additional protection, such as felt gaskets, may be necessary. If used in an atmosphere containing corrosive gas it may be desirable to use cadmium or chromium plate on metal parts and special paint on other parts to protect the switch. When mounted out-of-doors a weatherproof case is necessary and occasionally an application is found which requires a watertight case, but they are rare and are generally confined to shipboard applications. As to the electrical contacts the necessary arrangement can only be determined by having a complete knowledge of the necessary control connections together with a complete cycle of operation. The most common and simplest application is to get a stop at each end of travel sometimes preceded by a slowdown, particularly if the inertia load is large. No simple rule can be laid down for correctly selecting the arrangement of electrical contacts, as operating conditions vary so widely on different applications. In general the electrical contacts in limit switches are of small current-carrying capacity, seldom over 10 amp., and consequently will not handle the motor current direct. For this reason contactor control is practically always used where limit switches are necessary.

Maintenance

Having installed the correct type of switch, it cannot be expected to continue performing correctly forever without attention. Limit switches, like all other machinery, have parts which wear out, nuts, screws and bolts to loosen up due to vibration and parts that can rust and corrode where operation is very infrequent, consequently a systematic inspection at frequent intervals is necessary to insure continuous satisfactory operation. There are at least two reasons why such an inspection is frequently overlooked; first, it is often necessary to locate limit switches in rather inaccessible places and, second, where used for emergency stops only and, therefore, operated infrequently, it is assumed that they are not subject to wear and tear.

Electrical contacts require the closest maintenance where a high degree of accuracy of operation is required and particularly where a failure means a costly accident. On some types of switches the operating point varies as the contacts wear away, thus requiring some change in adjustment as the wear continues. At times the contacts must be renewed. Bolts and nuts which hold the switch in place must be kept tight, and particularly those having to do with adjustments and those clamping current-carrying parts together. Lubrication is about the only other maintenance required, but that must not be neglected.

Limit switches are labor saving devices and provide insurance against accidents, consequently they deserve a reasonable amount of care.

INDUSTRIAL ENGINEERING

Electrical, Mechanical and Plant Service in Industry

L. C. MORROW, *Editor*

Chicago, July, 1929

Are Performance Records Making Your Summer Work Easy?

AT this time of the year, service-to-production departments are beginning to prepare for the high production requirements of the winter months.

This work of preparation involves the introduction of new and modern equipment, replacement of more parts and units, repair of lighting systems, buildings, and so on.

Whether the directive duties connected with these activities prove easy or difficult will depend upon the efficacy of the department system of recording condition and performance of equipment.

To those plant engineers who have learned the value of records of inspection, repair, and performance, there is no need of further suggestion. It is in order, however, to again point out to the men who have been careless in this respect that they can be much more certain what is ahead of them if they will keep records. This year's job of preparation would have been evident in advance from performance data systematically recorded, compiled, and analyzed.

Pick the Dollars Out of Your Scrap Pile

DISPOSAL of waste materials from production processes is of necessity handled more or less systematically in most plants. In too many cases, however, an entirely different situation exists in the matter of disposing of the odds and ends of material, commonly known as "scrap," that accumulate so rapidly around every busy plant.

In the rush of making repairs or changes and keeping the plant going, it is easy to overlook the fact that old copper, brass, iron and the like have a definite market value and, therefore, represent dollars that might better be in the bank than scattered around the plant yard and buildings. Hence, little attention may be paid to these piles of hidden dollars until an executive order or the impending arrival of visitors forces a thorough, but costly, clean-up. Under such conditions, the object of the clean-up usually is to get rid of the offending material as quickly as possible, with little or no thought of disposing of it at a profit.

During the summer months an unusually good opportunity is afforded of collecting all scrap that has collected through the busy winter season. It is almost inevitable that such scrap should contain some usable parts or materials; hence it will usually pay to have it sorted by a responsible workman. In any event, it will not be difficult to induce a local junk dealer to exchange for an eyesore and liability in the plant what may be a surprising number of perfectly good dollars in the bank.

Handicaps in the Transportation of Materials

IN these days of transportation within the plant by means of industrial trucks the lack of elevators of sufficient capacity to carry the loaded trucks frequently is a handicap. It is not surprising that this condition exists in old plants; the men who built them, like the builders of public buildings now ten or fifteen years old, did not understand the greater demands that time would bring.

In the new construction of today there is little excuse for not anticipating the maximum loads that will have to be handled as methods change and time goes on. Remedies are possible in buildings wherein the materials handling systems are being revised. Consideration should be given both bulk and weight of loads.

Aisles too narrow and doorways either too narrow or without sufficient headway constitute additional handicaps in some plants that could otherwise use trucks to advantage. Industrial trucks of great weight and capable of carrying several tons are being built. Some of them are equipped with lifting booms that require as much as 14-ft. headroom. The possibility of obtaining maximum service from them is much reduced unless aisles and doorways permit their passage.

Ramps in many cases are necessary adjuncts to industrial trucks, in transporting materials from yard to building. Usually it is necessary to have a platform of the right height for loading and unloading freight cars, and it is detrimental if this platform is not connected with ground level by a ramp. Unfortunately space limitations sometimes do not permit the addition of a ramp to old buildings. In new construction ramps should be included by all means, and in some existing plants reconstruction of a portion of the plant to include a ramp is justifiable.

There is much concerning the economical handling of materials to be learned by industrial plants, particularly the small ones and those of medium size. Among the early truths to be grasped are these concerning elevators, aisles, doorways, and ramps.

Iron and Steel Exposition a Success in Spite of Handicaps

THE Iron and Steel Exposition held last month in conjunction with the twenty-fifth annual convention of the Association of Iron and Steel Electrical Engineers was a success in spite of the handicaps that it faced.

With the exhibits split into two groups, the visitors were obliged to travel between basement and seventeenth floor in elevators that fell far short of having perfect ventilation. Moreover, the weather was extremely warm.

The size of the exposition and the division of space among a number of rooms on the seventeenth floor necessitated a somewhat choppy arrangement of exhibits. It is not unlikely that the visitor at times felt as though he were in a maze.

Announcement of the list of exhibitors and their products prior to the show was not as extensive as might have been. The primary market intended to be reached through the exposition is, of course, the steel mill group. Yet so long as the exhibits are together it would seem logical to give them a greater audience by informing other interested industries of the opportunity to view the equipment. As things were, the exposition was well attended and exhibitors spoke well of the "quality" of the visitors.

The engineer is informed by salesmen, by news accounts and advertisements of equipment as it is placed on the market, but he welcomes the opportunity once a year or so of seeing a great bunch of new and improved equipment in operation under the direction of expert hands. He likes, also, to see it away from the plant where he cannot let the details of his work distract his attention.

Simplification of Industrial Truck Tires Deserves Your Support

USERS of industrial trucks will receive good news in the announcement that a simplified schedule for industrial truck tires, reducing the varieties now produced to a stipulated number of standard sizes, was recently approved by a general conference of manufacturers, distributors and users of these tires. The conference was held under the auspices of the Division of Simplified Practice of the Bureau of Standards.

Possibilities for the development of this simplification program have been studied for some time by the Committee on Standardization of Industrial Tires, of the Tire and Rim Association of America. This program covering standard dimensions and tolerances for wheels and tires has been approved by the membership of that association.

A report of the conference, with an acceptance blank, will be sent to manufacturers, distributors, and representative users of industrial truck tires. When signed acceptances have been received, representing not less than 80 per cent of the volume of production, and satisfactory distributor and user support, the simplified practice recommendation will be published by the Bureau of Standards. The recommendation will become effective on September 1, 1929.

Under the simplification program of the Bureau of Standards, a large number of products have been studied and standardized at a saving to American industry of hundreds of millions of dollars annually. In the present instance, standardization of industrial truck tires will mean that the demand will be concentrated upon the standard sizes, thereby promoting reduction of stocks, faster turnover, and better service.

It is to be hoped that prompt and hearty support of the new recommendation will be forthcoming immediately.

Good Artificial Lighting Provides "Sunny Days"

NATURALLY the greatest benefits of improved lighting are obtained in cases where a very poor and dilapidated lighting system has been replaced by a good one. The improved results which are manifested in records of production, materials, and accidents are not due entirely to better seeing on the part of the workers. There is a more subtle influence too commonly ignored. This is the psychological effect of an adequate intensity of illumination free from glaring light-sources and harsh shadows.

None of us is strong enough to resist the influence of certain powerful environmental factors. On a sunny day outdoors there usually is a spring in the step and a cheerfulness in the voice. These are relatively subdued on a so-called gloomy day and the gloom often penetrates so that it conspicuously affects viewpoint and attitude. There are practically no scientific data on this subject, but are they needed?

Those who desire more data will be interested in the results obtained by a research laboratory. A number of individuals were given a job of sorting perforated cards, which could be done solely by touch. Each wore a pair of goggles equipped with lenses of frosted glass. The work was done in a room alternately in total darkness and highly illuminated. Even though the workers could not see the work in either case, they did eight percent more work when the room was illuminated than when it was in darkness. This increased production was the result of the stimulating effect of light entering the eyes.

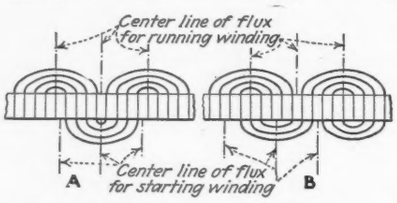
AROUND THE WORKS

Troubles Met in Changing Speed of Single-Phase Motor

SOME time ago a General Electric ¼-hp., single-phase, four pole, 110-volt, split-phase, Type SA. motor was brought in to be rewound for half speed. This motor was of the wound-rotor type, having 36 slots.

The slots were not of uniform size; that is, the slots in the middle of the poles were smaller than those on the outside, as these small slots accommodated only the starting winding.

In changing the number of poles it was found difficult to distribute the winding for eight poles. The job was also complicated by the fact that there were only 36 slots, which number is not divisible by 8. It was eventually decided to wind the running winding



IT WAS NECESSARY to change the distribution of the starting winding in order to secure the necessary phase displacement for starting.

* * * *

in the same way that was originally used, but connect it for consequent poles and double the number of turns. Therefore, it was necessary to use as large a wire as the slot would accommodate and still leave room for the starting winding.

The reason for this was that as the speed was reduced one-half the counter-electromotive force developed would be only one-half; therefore, to produce the necessary counter-voltage for operation at 110 volts it would be necessary to double the number of turns.

However, we had to distribute the starting winding in a different manner, as it will be seen from diagram *A* that the center of the flux developed would fall in the same position as that developed by the running winding if the original arrangement were used. Therefore there would be no phase displacement.

Diagram *B* shows how the starting winding was staggered to allow the starting winding flux to be 90 electrical degrees out of phase with the flux of the running winding.

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THIS SECTION *is especially devoted to short articles describing ideas and practical methods devised to meet particular operating conditions. The items may refer to mechanical details of installation, inspection, testing, wiring, repair, maintenance, replacement, and emergency or unusual installations of equipment tributary to production. Special attention is given to shop or bench tools and short cuts or improved methods of handling work brought into the repair shop. Contributions from our readers are always welcome.*

* * * *

Automatic Control for Board Tipple

AT the plant of the Mason Fibre Company, Laurel, Miss., a very unique scheme for the automatic control of a tipple is used. This has been in operation for several months and so far has proved very satisfactory. The equipment consists of the following:

4 Limit switches
1 15-amp. magnetic switch
1 Magnetic switch without relay
1 Magnetic switch with relay
1 Magnetic reversing switch, without relay
1 3-hp., 900-r.p.m. motor with tapered shaft extension on opposite end from pulley, for mounting solenoid brake for fiber mounting gravity set.

By referring to Fig. 1, a general idea of the equipment and of the tipple itself may be obtained, as the details show how the various limit switches are installed on the tipple.

The wiring diagram in Fig. 2 shows the connections, and the general scheme of operation is as follows:

The fused disconnect switch is closed and the tipple is started in operation by closing either one of the single-pole snap switches. As no board is in the tipple, limit switches *C* and *D* will both be closed, and switch 1, which operates as a line switch, will close. As one of the single-pole snap switches has already closed one side of the reversing contactor, the motor will operate, at the same time taking off the solenoid brake by energizing it, which will start rotating the limit switch designated as switch *D*.

The motor will remain running and raise or lower the tipple the height of one rack until a pin on the wheel of the motor shaft revolves one turn and knocks off limit switch *D*. At the same time, a board will start through the tipple, come under limit switch *C*, open this circuit and go on into that shelf in the rack.

As soon as the board leaves the table of the tipple, limit switch *C* will close again and as limit switch *D* is set so that it will have a small amount of overtravel and has a spring return, it will close again after operating. The tipple will go through another cycle and raise or lower the distance of one rack.

Limit switches *A* and *B* are located at the top and bottom of the rack respectively, and are operated by a projection on the table of the tipple so that they will change the connections in the coils of the reversing switch. Thus the tipple will automatically reverse at the end of the travel at each

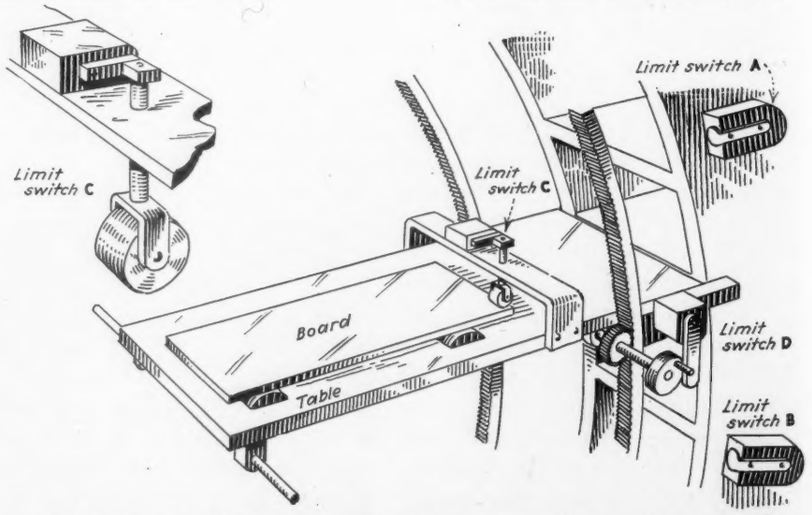

FIG. 1—Tipple with arrangement of limit switches for automatic operation

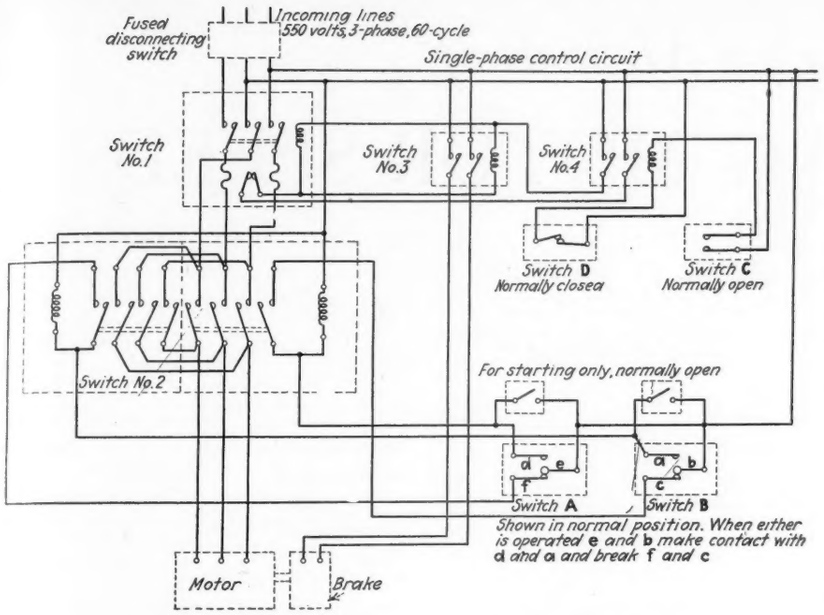
Fused disconnecting switch
Incoming lines 550 volts, 3-phase, 60-cycle
Single-phase control circuit
Switch No.1
Switch No.3
Switch No.4
Switch D Normally closed
Switch C Normally open
Switch No.2
For starting only, normally open
Switch A
Switch B
Shown in normal position. When either is operated e and b make contact with d and a and break f and c
Motor
Brake

FIG. 2—Scheme of connections for automatic tipple control

end of the rack and go up and down continually as long as boards are coming through it.

In the drawing of the tipple and the rack, Fig. 1, limit switch *C* is not shown at the end of the table. However, this switch is located at the extreme end of the table so that it will not be possible for the table of the tipple to either raise or lower while a board is being delivered from the table.

The motor and solenoid brake are, of course, not shown in this illustration, but are directly connected to the shaft on which the gear is shown to move up and down on the rack. The wheel with the pins to operate limit switch *D* is directly connected to the same shaft.

To stop the equipment from operating it is only necessary to open the disconnect switch. The equipment may be started again in either direction, raising or lowering, by closing the corresponding single-pole snap switch, as before.

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Uses for a Disk Grinder in the Repair Shop

IN the selection of machinery for a repair shop, the writer would unhesitatingly designate a disk grinder as one of the most important items. The reasons for this high rating are numerous, although not many men stop to consider them.

In the first place, a disk grinder affords a means of producing flat surfaces when no miller or shaper is at hand. A considerable amount of metal may be removed at rates that are fairly high, although not up to production speeds. The vogue for hardened parts makes the disk grinder still more important. Bearings may be disked off at their dividing line much quicker than by filing. Glass may be ground off and the edges smoothed on the face of a disk grinder; this is, in fact, about the only good way to trim up the edges of sections of plate glass used as shields and for other industrial purposes.

Where cast iron and steel, the red metals, aluminum, glass, Bakelite, fiber, babbitt, and so on may all be encountered in a day's work, two or more grades of abrasive disks may have to be kept on hand—say, a different grade on each side of the disk wheel—to handle the different materials most efficiently. If the shop is small, however, the use of a general-purpose disk would prove most economical.

Any motor of ½-hp. rating or more can be rigged up to do disk grinding. A 1-hp. motor has a shaft stiff enough to carry a 10-in. disk. A motor speed of 1,800 r. p. m. is safe for a cast-iron disk 12-in. in diameter, if it is balanced.

For use on an electric motor, the disk should preferably be made flat on one side and with a hub on the other, the length through the whole being nearly as great as the shaft projection. The hole should be reamed to a neat fit on the shaft and be keyseated. Then, a safety setscrew should be put over the keyseat where it can bear upon the key when inserted and keep the disk in position longitudinally. Such a disk is merely a flange and hub, accurately turned and perfectly straight on one side.

The abrasive cloth or paper is cemented on one side. In lieu of a clamp, the disk may be weighted down heavily on some other true metal surface and left overnight. Abrasive cloth is more durable than paper, often showing three times the life.

If a disk is used on a motor shaft, some means of taking the thrust should be provided. Electric motors do not have shoulder area for anything more than the lightest of thrusts and to take the thrust of disk grinding against the exterior of the end frame would induce heating and rapid wear at motor speeds. For that reason a ball thrust bearing should be provided; one of these simple thrust bearings may be bought in the inclosed type for less than a dollar and provides a splendid means of absorbing what is otherwise a heavy load.

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Simple Method of Soldering Aluminum Wire

A FEW years ago when I was in charge of a street railway substation I found, among other things, that the voltage on the trolley wires was low, especially on heavy loads. It was soon discovered that the trouble was in the cable pit at the junction of the copper generator cables and aluminum feeder cables. There were five 1,000,000-circ-mil. cables. These came down the wall and joined the copper cables. In making the joint the cables had apparently been squeezed together, wrapped with binding wire, surrounded with clay, and the interstices filled with half-and-half solder.

This joint held up until the station load increased to about full capacity, when the solder began to melt and run out.

In order to remedy this condition, the lightning arresters, choke coils, and so on, were mounted higher on the wall and the copper cables extended to reach them. It was then necessary to solder terminals to the aluminum cables, and the method I used may be of interest to others.

To make the solder, four parts by weight of block tin were melted and one part of zinc was added, quickly and thoroughly stirred, and the mixture then poured out into thin strips convenient to handle. For a flux I used stearic acid, which is obtainable at any drug store.

Each cable was cut to the proper length and the strands opened out, scraped, cleaned, heated enough to melt the flux, scraped again while hot and the solder applied. After all the strands were thus "tinned" they were bunched together and forced into a brass terminal which was then filled with ordinary solder. These joints have been in service twelve years and show no signs of turning black or weakening in any way.

In soldering aluminum the main point to remember is that it oxidizes or rusts immediately upon exposure to air; hence, by keeping it covered with the melted flux, while scraping the surface to be soldered, the air cannot reach and oxidize this surface.

Fairmont, W. Va. PHILIP N. EMIGH.

Two Methods of
ADJUSTING MOTOR SPEEDS

By H. D. JAMES
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IN the May issue several of the more widely used methods of starting and controlling the speed of a.c. and d.c. motors were described. In this article the principles involved in regulating the speed of motors by varying the field strength and voltage will be considered.

Field control is used with shunt motors for adjusting the speed of the motor by means of a field rheostat,

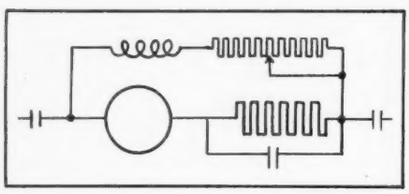

Fig. 1—Field and starting control for a shunt-wound motor. The speed is controlled by adjusting the field strength.

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Fig. 1. In addition to these rheostats, other control means must be used for starting the motor. When the motor speed is changed throughout a wide range, a relay is used to retard the change in field strength, so as to keep the armature current within prescribed limits. These relays are used on standard motors having a speed range in excess of 2:1, and sometimes for a smaller speed range, depending upon the size of the motor.

Motors that have their speed controlled in this way operate at substantially the same speed, independently of the load. The only variation in speed is due to the voltage drop through the armature and other series windings of the motor. On account of the close speed regulation this method of control is known as an "adjustable-speed control." The field rheostat carries only a small percentage of the total current, so that the losses are small and the rheostat itself is compact and inexpensive.

Some standard motors can have their speed range adjusted over a 2:1 range without any change in the design, provided the maximum speed does not exceed a safe limit.

The size of an adjustable-speed motor is fixed by the power output at the minimum speed. The maximum speed is fixed by the mechanical strength of the rotating parts. If it is necessary to provide a wide speed adjustment, a relatively slow speed must be used for the lower limit. This will usually make the motor larger than normal, if it is required to develop constant horsepower throughout the range.

It is important to use a substantial type of field rheostat, as any variations in the conductivity of the switching member will cause a fluttering in the speed of the motor.

The adjustable-speed type of motor has a very wide application; some of the more important uses are:

1. Machine tools, particularly lathes, reversing planers and boring mills.
2. Fans and centrifugal pumps.
3. Textile machinery.
4. Wire drawings and insulating machinery
5. Elevators.
6. Central station auxiliaries, such as stokers, feed water pumps and so on.

The control apparatus for small motors often consists of a combined starting and field regulating rheostat, Fig. 2. Where a more rugged form of manual controller is desired, particularly for the larger motors, the drum or cam type controller, Fig. 5, is used in combination with a field rheostat operated from a common handle. Often the field rheostat takes the form of a drum cylinder with separately-mounted resistors. Control of this type has been applied to motors of 500 hp. driving the draft fans used with steam boilers.

Magnetic control is frequently used with a separate field rheostat. This control is common in four general arrangements, as follows:

1. Non-reversing.
2. Non-reversing with dynamic brake.
3. Reversing.
4. Reversing with dynamic brake.

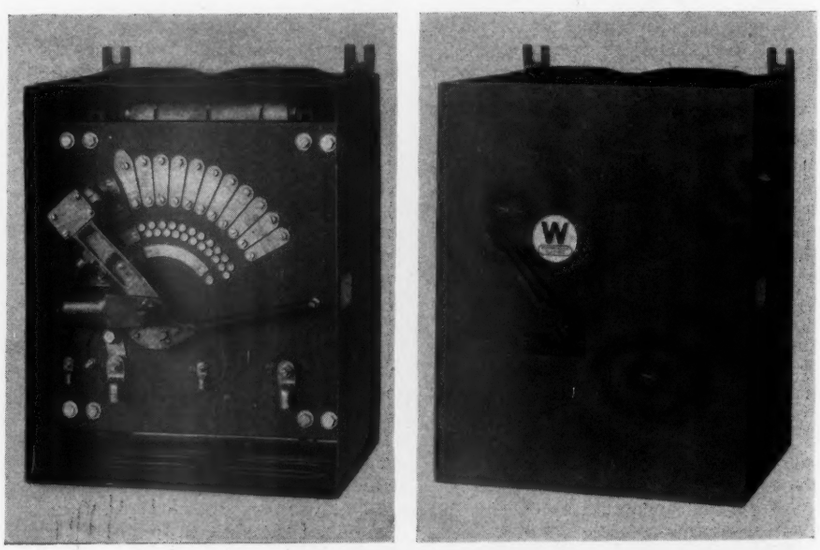


Fig. 2—Starter and speed regulator for small shunt and compound-wound d.c. motors. With such a control, which consists of a faceplate and resistor, it is possible to obtain 50 per cent speed reduction below normal by armature control, and up to four times normal speed by field control depending on the design of the motor.

Special arrangements of magnetic control are made for particular applications. Sometimes it is desirable to obtain automatically a definite sequence of operation; this can be worked out very nicely with magnetic control. It is usually better to provide a separately-mounted field rheostat, as this permits the contactor control to be mounted in the most convenient place, which may not be accessible to the operator. The field rheostat can be mounted

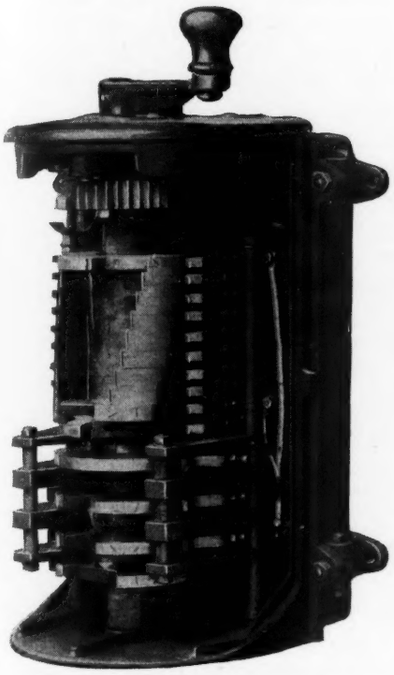


Fig. 3—Drum controller for starting and controlling the speed of adjustable-speed, shunt-wound, d.c. motors for machine tool and similar duty.

* * * *

directly on the machine close to the push button station, where it is convenient for the operator. Inasmuch as the field rheostat and push buttons handle only a small current, there is little danger of burning the operator due to flash in these parts of the control. It is always best to keep the main control remote from the operator, particularly in the larger sizes.

Field Control for Direct-Current Series Motors

A very interesting application of field control for a series motor is found in the crane hoist controller, Fig. 4. In hoisting, the series motor operates in the usual way. When lowering, the motor armature is connected in parallel with the field and each is energized by connections to the line. If the crane hook is lowered empty, the motor operates as an ordinary shunt motor. If the load is heavy enough to overhaul the gearing and drive the motor as a generator, the regenerative current passes through the field windings and the motor operates as a compound generator. The speed of lowering is controlled by adjusting the field strength and changing the resistance in the regenerative circuit.

Speed Regulation Through Voltage Control

One of the early advocates of voltage control was Mr. H. Ward Leonard. It has, therefore, been known to some persons as the "Ward Leonard method of control." It is also known as "variable-voltage control" and "generator field control."

As shown in Fig. 5, the method consists in providing a separate d.c. generator for each working motor. The voltage applied to the motor is adjusted by changing the strength of the generator field. If this field is reversed, the working motor is also reversed. When such an installation is operated from an a.c. power circuit, it usually consists of a motor-generator set having an a.c. driving motor, a d.c. exciter and one or more d.c. generators; sometimes two generators are used, each controlling a different working motor.

The control consists of a reversing field rheostat for the generator and sometimes a field rheostat for the motor, when a wide range of speed is desired.

When this method is used for motors connected to an intermittent load having short time peaks, a flywheel is added to the motor-generator set and the driving motor is of the wound-secondary type. A liquid controller is used in the secondary of this motor and the position of the electrodes is controlled by a torque motor.

When the load increases above a fixed value, the torque motor separates the electrodes, which increases the resistance in the secondary circuit of the driving motor. This permits the motor-generator set to slow down and use some of the stored energy in the flywheel. When the load drops below a fixed value, the torque motor moves the electrodes closer together, which speeds up the motor-generator set and stores energy in the flywheel. A flywheel arrangement of this kind may be used on any size of motor, but its expense and complication are justifiable only in the case of large motors.

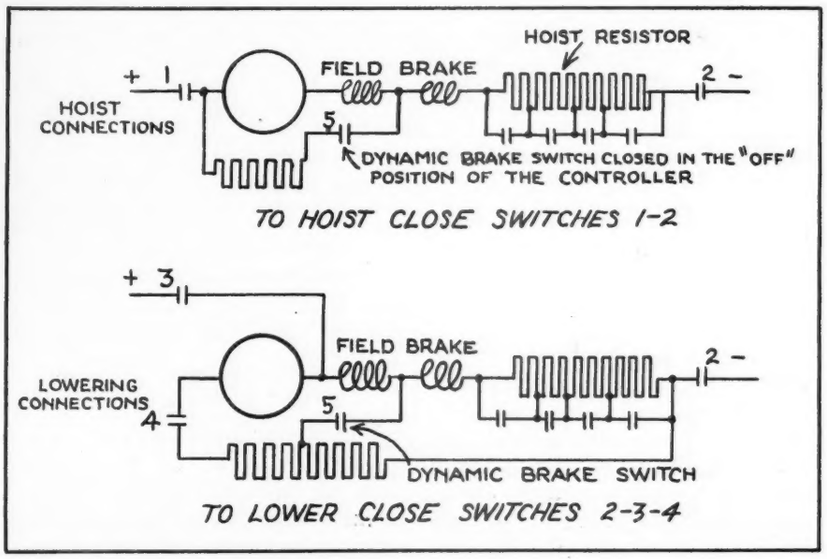


Fig. 4—Application of field control to series motor in hoisting service.

This method of control has been applied to motors of several thousand horsepower, which may be reversed every few seconds when used for driving the main rolls of a steel mill. It is the only practical method for the rapid reversing of these large motors.

On the whole this method of control has greater flexibility and perhaps more good points than any other method. With it any speed can be obtained between zero and full speed in either direction of rotation, and the speed values are maintained under all conditions of load within the percentage regulation of the machines. Where very close regulation

is necessary, such as for elevators, it can be made substantially 100 per cent by properly compounding the generator and adding some other control refinements.

The control itself is very simple and relatively small, as it handles only the field current of the generator and sometimes that of the working motor. It is successful in reversing the largest motors required by industry, with very smooth acceleration and deceleration. When decreasing the speed, the working motor regenerates at all speeds and returns some power to the line. The change in speed has a magnetic time delay which can be made anything within reasonable limits by properly designing the machines.

The power taken from the line when starting is very small, even though considerably more than full-load torque is required, because current is furnished to the working motor at a very low voltage. If we assume that this voltage is 20 per cent of normal and the current through the motor is 200 per cent of normal, the power taken from the line will be only a little more than 40 per cent of the full-load demand.

When the motor-generator set has a flywheel, the stored energy of this flywheel will furnish power for operating the working motor for some time after the power supply is disconnected. This feature has been taken advantage of in some mine hoists to raise the workmen if the power supply is interrupted for a short interval of time.

The use of the individual generator requires the motor-generator set to be operated continuously so that its no-load losses may reduce the efficiency of the electric drive if the operating cycle is infrequent, but it can be shut down if the intervals between operations are long enough. The cost of the motor-generator set is more than the saving in the cost of an ordinary rheostat control, but in many cases the difference in the cost of the entire installation is not materially affected, and the many advantages of this method of control justify the extra expense for a large number of applications.

The design problem is somewhat involved and it is very desirable that the motor, generator, and control equipment be designed as a unit by engineers experienced in this work. Good results may not be obtained if a general-purpose motor-generator set is connected to a standard motor and this method of control used.

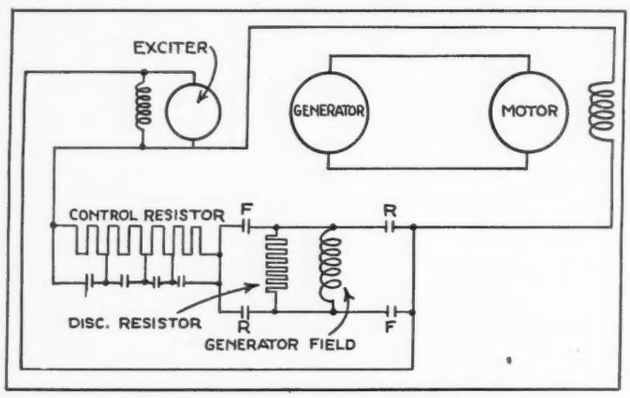


Fig. 5—Scheme of connections for the variable-voltage or Ward Leonard system of control, using a separate d.c. generator for each motor.

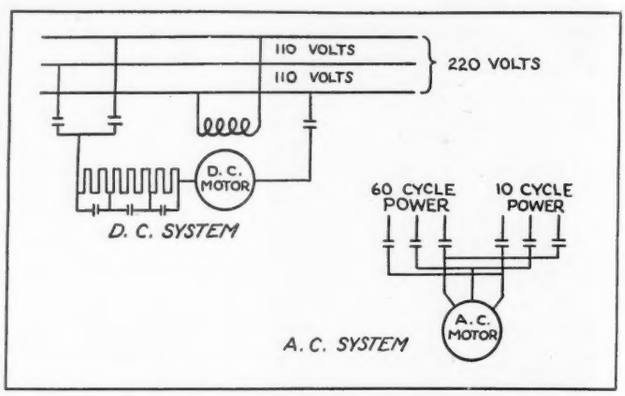


Fig. 6—In this system three or more wires are used to deliver direct current at different voltages, or at different frequencies and voltages, in a.c. systems.

Principles of Multi-Voltage Control

One of the oldest methods of adjusting the speed of d.c. motors made use of power delivered at different voltages, as in Fig. 6. Several power wires were used and the motor was connected between pairs of these wires to give different fixed voltages. The shunt field was energized by a fixed voltage and the finer speed adjustments obtained by changing the field strength.

A multi-voltage system for a.c. motors requires a different frequency for each voltage. For applications requiring a slow starting speed, such as paper calenders, a low frequency has been used for starting the machine. The power required at this low frequency is limited, so that one small generator is sufficient to furnish power to a number of machines.

The advantages of this system of speed control are the fixed operating speed corresponding to each voltage or frequency, and the elimination of rheostatic losses at these speeds. Where a wide range of speed is required, the use of multiple voltage keeps the design of the motor smaller than in the case of single-voltage control.

There are some serious limitations which have made this method of control less desirable for many applications than other available methods. In the first place, it is necessary to have a special motor-generator set to supply the different voltages or frequencies; power wires must be run corresponding to each voltage or frequency, and care must be exercised to balance the load between the different wires carrying power.

In changing from a higher to a lower voltage or frequency, resistance must be introduced into the circuit to limit the regenerative action of the motor. When this transition takes place, the generated voltage of the motor is higher than the power supply, and, therefore, a reversed torque is developed due to the reversing of the current in the motor. This torque may be violent unless resistance is inserted in the circuit. As soon as the motor speed is decreased to its normal value at the reduced voltage, the current passes through the motor in the proper direction to give positive torque. The reversal of torque in passing from a higher or lower voltage or frequency is objectionable for some applications and must be handled with considerable care.

This method of control has been most widely used in connection with machine tools, elevators, and paper and rubber calenders; the latter applications seem to be the only ones that are active at the present time.

The control equipment is either of the manual or magnetic type.

QUESTIONS
Asked and Answered
By Readers

[HERE IS A PLACE *where you can get some inside information when you get stuck. The only condition is that you do a good turn to the other fellow when he asks a question that you can answer from your experience*]

Voltage Regulator Causes Radio Interference

I wish some of our readers would tell me how to eliminate radio interference caused by our voltage regulator. Our excitors are of 17.5-kw. capacity and the regulator is a G.E. No. 6337, Type TA 125, Form L, which has always worked satisfactorily. The contacts of the regulator are kept in good shape and are replaced when necessary. A small arc is, of course, formed when the contacts of the excitor circuit are broken. This creates an interference which can be heard throughout the city for a distance of about one-half mile from the power plant and seems to be picked up more easily with an all-electric set. We have tried to eliminate this interference by installing an additional condenser, grounding the middle point, and in various other ways, but without success. R. E.
Two Harbors, Minn.

* * * *

Measuring Belt Tension

In articles on the use of belting for power transmission, the statement is frequently made that the tension on the belt should be so many pounds per inch of width. No doubt this is an important point, but I should like to know how I can measure the tension of leather, rubber or fabric belts while they are on the pulleys. Is there any apparatus or reasonably simple method of measuring belt tension, that can be used out in the shop? W. E. F.
Detroit, Mich.

* * * *

Running Distribution Lines When Frequent Changes Are Necessary

The seasonal nature of our product and continual enlargement of the plant necessitate frequent and radical changes in layout. Sometimes whole departments are completely changed or moved to another location. Many of our machines are individually driven, some of the motors being of 40-hp. rating. At present all of the power and lighting lines are run in conduit, but the heavy cost of putting up and tearing down our conduit installations makes me wonder if anyone has devised a method or system of running power lines that permits changes in layout at low cost. I wish that readers who have to meet the problem of frequent changes would tell how they run their lines so that the cost of such moves can be kept down. R. F. B.
Grand Rapids, Mich.

* * * *

Adapting Transformer for Welding Service

We have an 8-kw. transformer which is wound for 100-220 volts on the primary and 6, 12, 24 and 60 volts on the secondary side. It is desired to use this transformer for electric welding and we should like to know whether it is possible to do so and, if so, what changes, if any, will be necessary. Will we have to use a line or secondary choke coil on the same principle as the choke coil in an arc lamp. If so, please give the necessary specifications for it.
Walla Walla, Wash. W. H. H.

* * * *

Use of Anti-Friction Bearings Under High Temperatures

The question of how high a temperature ball or roller bearing can stand has come up in connection with the installation of some new machines. The bearings of some 1 7/16-in. shafts, turning at 200-400 r.p.m., will be subjected to a temperature of 200-250 deg. F. and must operate continuously. To avoid these temperatures would entail expensive changes that we do not want to make now, if it can be avoided. We have been using plain bearings, but have had considerable trouble with them, due to the difficulty of securing proper lubrication. The use of anti-friction bearings has been suggested, and I should like to know the experience of other readers with such bearings under similar conditions, particularly as regards abnormal wear, kind of lubricants to be used, troubles that may be expected, and any other points that will be helpful. J. M. L.
St. Louis, Mo.

* * * *

Changing Single-Phase Motor for Three-Phase Operation

We have a motor-generator set for charging batteries, the motor of which is wound for 60-cycle, single-phase operation, with a squirrel-cage rotor. A double-throw switch is used to start the set on battery current, after which the a.c. power is applied. The name-plate has been lost, but the motor is presumably of 5-hp. rating and I should like to rewind it for use on a three-phase, 220-volt, 60-cycle supply. There are 48 slots in the stator. The present single-phase winding is arranged for four poles, each pole having four coils, consisting of twelve turns of No. 10 wire. The coils are connected in series for 220 volts. One-third of the slots, four for each pole, are left empty. Will some reader please tell me how to calculate a three-phase winding for this motor? J. E. P.
St. Louis, Mo.

* * * *

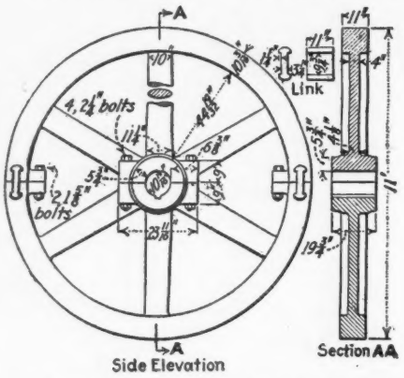
Supporting Brick Walls Where Holes Are Cut Through

We are installing a conveyor system between departments, and it will be necessary to cut holes through several interior brick walls supporting part of the weight of the upper floor, and separating the departments. These holes will be about 4 ft. wide and 3 ft. high. The walls are about 8 in. thick and we are wondering whether, if we cut square holes, it will be necessary to use I-beams to support the bricks above the holes. In one case there will be 17 ft. of wall above the hole: in other places the height ranges from 12 to 15 ft. Would there be any advantage in cutting the hole rounding, or arch-shaped, or pointed at the top? We should like to avoid putting in I-beams, but do not want the walls to be dangerously weakened. Your advice will be appreciated. A. I. M.
Newark, N. J.

ANSWERS *Received to Questions Asked*

Determining Safe Speed of Flywheel

I should like to know the maximum safe speed of a Corliss valve engine flywheel, which is 11 ft. in diameter and of cast-iron construction. It is shown in detail in the diagram. As will be seen, the rim joint consists of a shrink link and inward flanges, with two bolts each. The hub is of the conventional split type, with



four bolts. The engine and flywheel are about 25 years old, and the engine is direct-connected to a 200-kw., direct-current generator, which it drives at a speed of 150 r.p.m. The load fluctuates from 25 per cent of rated load to 100 per cent of rated load. Any information that readers can give me will be very much appreciated. W.H.
New York, N. Y.

REPLYING to the request by W. H. in the February number of *Industrial Engineering*, page 80, Prof. Benjamin conducted some very interesting and valuable experiments on the bursting of flywheels many years ago, the results of which may be found in the transactions of the A. S. M. E. of 1899 and 1902.

The closest approach in design to that sketched by W. H. failed at a rim speed of 305 ft. per second. That flywheel, also, had six arms. The efficiency of construction was estimated at 49 per cent.

But W. H. asks for the "safe" speed. "Safe" speed of a flywheel is largely a matter of judgment. If it would burst at a speed of 305 ft. per second, some engineers might say that it surely should be safe at a speed of 150 ft. per second. Cast iron flywheels are operated at speeds of over 190 ft. per second, which is more than 2 miles per minute.

Usually a speed of about one mile a minute is considered about right for cast iron flywheels. Cast iron, as most engineers know, is a rather treacherous material to work with, especially for tensile service as in flywheels. There always is the possibility of internal strains, blow holes, and other imperfections in manufacturing.

In view of the fact that one of Prof. Benjamin's flywheels burst at a speed of 194 ft. per second, I would be inclined to play safe and wouldn't run this one faster than 150 ft. per second. Prof. Benjamin's design which burst at 194 ft. per second was like this one, with the exception that it had no shrink link. It was bolted, only. The design shown by W. H. in the illustration on this page is considerably stronger, of course.

Newark, N. J. W. F. SCHAPHORST.

Reducing Speed of Slipring Motor

We have a 5-hp., 440-volt, three-phase, 1,135-r.p.m., Allis-Chalmers slipring motor whose rotor draws 44 amp. at 56 volts. We want to have this motor operate with a speed range of 1,135 r.p.m. to 567½ r.p.m., or a 50 per cent speed reduction. Can some reader tell me whether this range of speed can be obtained? Also, what value of resistance will be required in the rotor circuit in order to obtain a speed of 567½ r.p.m.? R.P.D.
Richmond, Va.

REPLYING to R. P. D., it is quite possible to obtain 50 per cent reduction in speed with a slipring induction motor by inserting a certain amount of resistance in the motor secondary.

The correct amount of resistance to be used depends on the load to be carried by the motor when it is running at 50 per cent speed reduction. For example, if the load is reduced 50 per cent when the speed is reduced 50 per cent we will get a curve like *2* in Fig. 1. This means that if enough resistance per phase is connected in the motor secondary so as to get a balanced, Y-connected resistor, the motor will exert 100 per cent torque at zero speed, but at 50 per cent torque the speed will be 50 per cent.

For instance, assume that the full-load secondary current of a motor is 44 amp. and the open-circuit voltage across the rings (motor at zero speed) is 56 volts. Then the amount of resistance required per phase is 56÷44= 1.27 ohms. This figure may not be exactly accurate because this resistance also includes the internal motor resistance, but the error is negligible. The

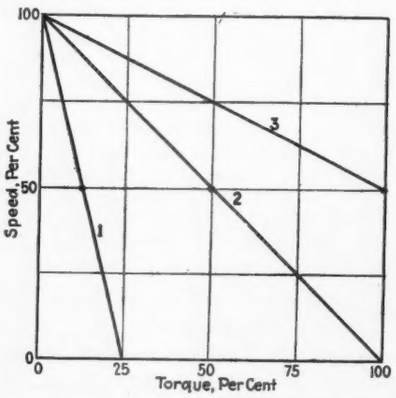


FIG. 1—SPEED-TORQUE CURVES of slipring motor with different values of resistance connected in the secondary circuit.

resistance should be connected as shown in Fig. 2.

If the load is to be maintained at 100 per cent with a speed reduction of 50 per cent the resulting motor curve is shown by *3* in Fig. 1. The resistance

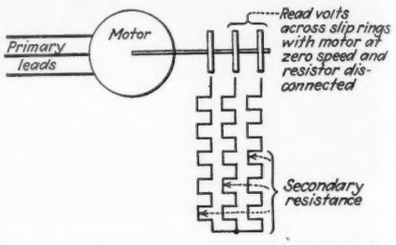

Primary leads
Motor
Read volts across slip rings with motor at zero speed and resistor disconnected
Secondary resistance

FIG. 2—METHOD of connecting resistance in secondary circuit of slipring motor for speed reduction.

* * * *

will then be half a great or, .63 ohm per phase instead of 1.27 ohms.

If the load is to be less than 50 per cent with a speed reduction of 50 per cent the resistance in the secondary circuit will have to be correspondingly greater. If 50 per cent speed reduction is required with a very large reduction in load, the speed-torque curve becomes very steep, as indicated by curve *1* in Fig. 1, and the speed becomes very unstable. In curve 1 an increase in load of 10 per cent will very nearly stall the motor and a reduction in load of the same amount would cause the motor speed to approach very close to synchronous speed.

Scotia, N. Y. R. F. EMERSON.

IN REPLY to R. P. D.'s question, the motor can be operated at 50 per cent speed reduction by inserting resistance in the secondary. The resistance per phase based on machine load, i. e., constant torque, is as follows:

$$R = E \times N \div 3 \times I \times K,$$

where

R = ohms per phase
E = open-circuit voltage between slip rings at standstill
N = per cent speed reduction
I = secondary current per phase
K = constant depending on N, which in this case is .80.

Then,

$$R = (56 \times .50) \div (1.73 \times 44 \times .80) = .46 \text{ ohms.}$$

Three sections of resistance would be required, each of .46 ohms and 44 amp. capacity, one for each phase, star-connected. The above calculation is based on a 5-hp. load, which, if reduced, will increase the speed. For example, assume the load to vary at times and be, say, 4 hp.; then to obtain 50 per cent speed reduction a value of .57 ohms per phase will be required.

E. H. LAABS.
Engineer,
Cutler-Hammer, Inc.,
Milwaukee, Wis.

ANSWERS *Received to Questions Asked*

IN order to answer R. P. D.'s question fully, it would be necessary to know what torque will be required at 567½ r.p.m.; in other words, what will the load be at one-half speed? This information is made necessary by the property of a slipring motor, which enables it to develop the same torque at different speeds, depending upon the value of the external resistance in the external circuit of the rotor.

The foregoing information can easily be obtained from the manufacturer in the shape of torque-speed curves, which show the relation of the torque and speed at the different values of resistance in the external rotor circuit.

If R. P. D. already has a resistance that will carry the maximum rotor current the test can easily be made.

C. O. VON DANENBERG.

New York, N. Y.

Meaning of Terms Used in Calculating Motor Windings

I should like to have some information on the meaning of the terms pole arc, pole face arc, tooth pitch, slot pitch, and slot contraction, which are employed in calculating motor and generator windings. How should measurements be taken for these factors? W.F.P.
Pittsburgh, Pa.

REGARDING W. F. P.'s questions, pole arc is generally expressed as the percentage of armature surface covered by the poles. This includes all poles; for one pole the arc is the angle *K*, Fig. 1, included between the two pole tips.

Pole face arc is the length of the arc or curved surface of the pole face, Fig. 1, at a radius *R* and angle *K;* thus pole arc and pole face arc are closely related, as one depends on the other.

Tooth pitch is the distance between the centre lines of any two adjacent teeth; this can be expressed in mechanical degrees as angle *B*, Fig. 2, or as a chord at any given diameter as *C*, Fig. 2.

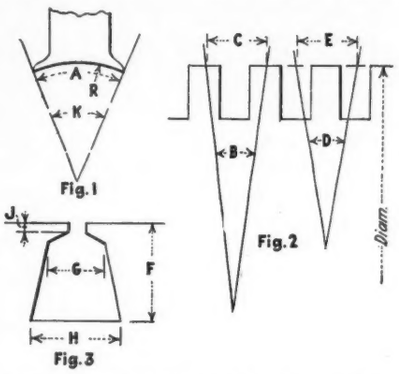
Slot pitch is the distance between the centre lines of any two adjacent slots. This can be expressed in mechanical degrees as angle *D*, Fig. 2, or as a chord *E*.

Slot contraction is a term sometimes applied to tapered slots of the type shown in Fig. 3, where the bottom of the slot, *H*, is wider than the top *G*. This contraction (*H-G*) reduces the room in the slot available for the winding, and thus affects the space factor.

W. F. P. also asks how to measure the pole arc, etc. Assuming that he has a stripped machine and wants to take physical measurements the following notes will enable him to take the data wanted.

The pole face arc can be measured directly with a tape line; to obtain the pole arc angle, *K*, use the pole face arc *A* expressed in inches. Then $K = (A \times 57.296) \div R$, where *R* is the radius of the pole face, which is one-half the pole face bore.

The slot or tooth pitch expressed in mechanical degrees equals 360 divided by the total number of slots or teeth; then the chords *C* or *E* can be found



THESE DIAGRAMS explain the meaning of pole arc, pole face arc, tooth pitch, slot pitch, and slot contraction.

* * * *

with a pair of dividers after the centre line has been marked off on two adjacent teeth. As angles *B* and *D* are equal, the chords *C* and *E* are also equal.

With tapered slots the number of wires of any insulated size that will fit into the slot, can be found as follows: $[(H+G) \div 2 - W)] \times (F + [J+D])$. This gives the total space available for wires and slot insulation and can be called *M* for convenience; then dividing *M* by the insulated diameter of the wire, the result will be the number of wires that can be wound into the slot.

In the above formula *W* is a factor expressed as a decimal that equals the allowance widthwise in the slot for insulation; that is, winding cells. *D* is the allowance depthwise for slot insulation which includes the wedge, separator, and winding cell. For 110- to 440-volt motors, *W* can equal .066 and D = .174. A. C. ROE.

Wilkinsburg, Pa.

What Changes Are Required with This Generator?

Will some reader suggest the best and most economical method of adapting a d.c. 15-kw., 125-volt, 120-amp., 1,500-r.p.m. G.E. generator for welding purposes? We have this generator which is driven by an a.c. motor on hand and would like to use them in this manner. W.F.S.
Wappingers Falls, N. Y.

IN regard to the question of W. F. S., assuming that the commutator can handle the increased current, I believe that the best method of changing over this 125-volt d.c. generator for welding purposes is to double up on the circuits of the armature and either parallel the field coils or else use a separate 125-volt exciter. A standard 125-volt, ½-hp. motor will be satisfactory as an exciter. If the generator is separately excited, it will not have so great a voltage drop from no load to full load as would be the case when it is self-excited.

A d.c. welding generator has a brush voltage of 50 to 60 volts with an average current output of 200 amp. When this machine is changed over it will have a brush voltage of 62.5 volts with a continuous output of 240 amp.

From the data given, I presume that this is a four-pole machine and that the armature has a two-circuit wave winding. This can be checked up by tracing the top and bottom leads of a common coil. For a four-pole, two-circuit wave winding the number of bar segments between the top and bottom leads of a common coil is either one-half, plus 1, or minus 1 bar of the total number of bars in the commutator.

Assuming that the armature has a two-circuit wave winding, I would recommend that he change the connection to a four-circuit lap winding with equalizers for every five or six coils. The bottom and the top leads must be raised from the commutator unless the bottom leads come straight out and the top leads are long enough to reach the bar adjoining the bottom lead. It is poor policy to attempt to splice commutator leads. Before changing the connections on the commutator, I would remove one bar from it and compensate for it by putting extra thicknesses of mica segments evenly distributed around the commutator. This procedure will give an even number of bars. The coil connected to the bar that is removed can be left out of the circuit.

The next thing to do is to put equalizers on the commutator. Without them, I doubt whether good results will be obtained, as the equalizers will help the commutation of the machine when under full load.

An equalizer should be connected on the first bar and the sixteenth bar. There should be approximately one equalizer for every five or six coils. However, if there are too many equalizers they will lower the armature resistance too much.

It will not be necessary to change the thickness of the brushes, but the carbon brushes should be replaced with metal-graphite brushes that will carry at least 100 amp. per square inch.

In case the armature has a two-pole, two-circuit lap winding, the only thing to do is to reconnect it for a four-circuit lap. Only the top lead need be raised in this case. The brushes must have twice the thickness of the original ones.

P. P. SCRIBANTE.
Electrical Engineer,
Star-Delta Electric Works,
San Francisco, Calif.

Linestart Motors Require Wider Pulleys and Wider Belts

By J. R. HOPKINS
Chicago Belting Company
Chicago, Ill.

THERE is a more or less new type of a.c. motor that is started by throwing it directly across the line, without a voltage-reducing device, with which wider pulleys and belts should be employed.

At the present time these motors are sufficiently new so that neither the motor manufacturer nor the plant user has given general recognition to the need for wider belts. However, this seems to be only a temporary condition, and before long we expect to see a wide acceptance of the need for wider belts on all linestart motors, and an increasing number of these motors equipped for belt drives.

What Linestart Motors Are

Linestart, or "across-the-line" motors are designed to be started on full voltage with starting currents within the limits prescribed by the National Electrical Light Association. Standard squirrel-cage motors are started by some form of voltage-reducing device, such as a compensator which is provided with several voltage taps so that the desired voltage may be applied. With such motors it is easy for the operator to control the load on the belt when starting.

With linestart motors full voltage is applied directly to the motor. The inrush of current is controlled by the design of the motor, but the operator can not control the load on the belt during starting. Linestart motors have a high starting torque and come from rest to full speed quickly.

It is estimated that about 15 per cent of all new motors manufactured today are linestart motors, and there are various estimates as to how extensively they will be used in the future. Five years from now 70 per cent of all new motors will probably be of the linestart type. The chief designing engineer of a large motor manufacturer says he can see no good reason why linestart motors should not supplant all standard squirrel-cage motors of more than 5-hp. and up to 30-hp. rating.

These motors are available in two different types: Normal-load linestart motors are one type; high-torque motors are the other. Both have a high starting torque, although the high-torque motor naturally has a higher load-starting capacity than the normal torque motor.

In spite of this higher starting torque, most of the manufacturers are selling their linestart motors of both types with pulleys of the same widths as used on standard motors. One reason for this is that pulleys for motors have been standardized and apparently the question of the proper pulleys for linestart motors has not been taken up. The motor manufacturers have apparently been engrossed with the purely electrical problems attendant on building successful linestart motors, and have succeeded very well, but they have, seemingly with only one exception, underestimated the effect of the starting load on the belt. One company has put out a linestart model with a pulley 50 per cent wider than the standard pulley, and is studying the whole question.

The motor manufacturers say that the effect of the higher starting load is only momentary and not enough to affect the belt. However, belt men known what happens when you ask a leather belt to carry repeatedly 200 to 300 per cent overloads.

What Happens When the Pulleys Are Too Narrow on Linestart Motors?

In actual shop practice it has been found that when linestart motors with standard pulleys were started up the pulley would spin around inside the belt; instead of this being only a momentary condition, lasting for a second or so, the pulley would very frequently spin for 30 seconds to three minutes. Spinning a pulley inside of a belt for that length of time plays havoc with the belt; it either comes off or is burned.

Starting trouble has not been confined to belts alone. The quick acceleration of linestart motors has also stripped the teeth from chain drives. When you have a chain drive and change the driving motor to a linestart design of the same size, and the new motor rips the teeth out of the chain belt that worked satisfactorily with the old motor, you can feel certain that the new motor has a starting load that the old one did not have.

Of course, the length of time the pulley will spin inside of the belt when the motor is starting depends on the load. Some loads are much harder to start than others, and the amount of load determines the length of time the belt will be subjected to an overload during the starting period.

Just as soon as the motor manufacturers understand the situation more clearly, they will, no doubt, put on wider pulleys. This subject has been brought to the attention of every manufacturer and it is to be expected that wider pulleys will soon be used.

How Much Wider Should the Belt Be?

Normal-load linestart motors require a pulley and belt from 20 to 25 per cent wider than would be used with a standard motor. That is, if the belt used with a standard squirrel-cage motor is 4 in. wide, a 5-in. belt will be needed on a linestart motor of the same size. This applies to all normal-torque linestart motors rating 7½ hp. and over.

High-torque linestart motors should be ordered with pulleys 50 per cent wider than for standard squirrel-cage motors of the same rating, when this rating is 10 hp. or more. On these motors the starting torque ranges between 2.38 and 3 times full-load torque, which neces-

Presented before a recent meeting of the American Leather Belting Association.

sitates a pulley and belt 50 per cent wider than the standard. Sometimes the starting load indicates that a belt a little less or a little more than 50 per cent wider is needed, but as a general rule the above figure seems to be about right.

The user should bear in mind the fact that when ordering a linestart motor, unless he specifies that the pulleys must be wider, and indicates how much wider, standard pulleys will likely be furnished, and trouble will result.

Where belts on linestart motors now in operation are giving trouble, the operator should see whether he can put on a heavier belt and increase the speed by increasing the diameter of the pulley. If that will not work, he should try increasing the diameter, and also increasing the pulley width about 20 per cent.

Linestart motor installations cost less than standard motor jobs. Whether the increase in the width of pulley and belt will change the prices very much, I do not know, but we estimate that even with the wider pulley and belt, the linestart motor will still be cheaper than the standard squirrel-cage motor and starting device.

Many plant men will have, or are now having, belt trouble in that their belts burn or wear out quickly. Under these circumstances they are likely to ask, What's the matter with the *belt* on these drives? They may lose sight of the fact that they have a new motor of a different type, and expect the same belt life from the belts on the linestart motors that they received on the standard motors.

When there are complaints about belt trouble from burning or short life, check up on the motor. If it is of the linestart type the fact that the starting loads may be greater and wider belts and pulleys needed, should be kept in mind.

The Incorporation of Safety in Electric Station Design

By V. R. BACON

United Engineers & Constructors, Inc.
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SAFETY for life, property and the continuity of service should be a quality inherent in all electrical structures and, being a fundamental characteristic, can be engendered only as an element of design.

Complete safety is unattainable, but this generality can never be a justification for laxity in the consideration of the specific details. The degree to which safety should be incorporated must necessarily be tempered by the nature of the equipment, the importance of the installation, various local conditions and the funds available.

Safety is clearly a general subject which cannot be discussed comparatively or quantitively without direct association with a specific problem. It is, therefore, the intention of this paper to consider the subject in a purely general manner without attempting to compare the various safety expedients or to specify their degree of application. Such decisions must be left to the judgment of the designers responsible for each individual project.

General Co-ordination

The possibilities of disastrous fires and losses can often be minimized by the installation of oil barriers on the floors of inclosures housing oil-filled equipment. Such barriers, if possible, should be made an integral part of the floor and so designed as to divert oil, accidently released, to proper drains. The barrier system is, of course, of little benefit unless the drainage system is of sufficient capacity and so designed as to insure the discharge of all free oil in a minimum time.

The choice of floor finish often becomes a vital factor in ultimate safety and serious falls can be averted by the proper correlation between the floor finish and equipment. Floors in the vicinity of oil-filled equipment often and unavoidably become oily during maintenance and emergency operations. If smooth finished, they may become very slippery, particularly when rubber heels are worn. Such floors should preferably be rough finished. Rough finishes, of course, make good housekeeping difficult and the finish chosen should consider that point.

The number and location of toilet and drinking water facilities is a matter quite often given too little consideration and, not infrequently, a false economy is affected by reducing such facilities to a minimum, particularly in the smaller plants. The number and location of these facilities should be so related to the location and importance of the various posts of duty that operators and attendants may be justifiably absent from their posts a minimum length of time.

Rotating Equipment

Short circuits and fire are probably the greatest and most common hazards to which rotating equipment is subjected.

The possibility and danger of short circuits cannot be entirely removed but the damage resulting from internal insulation failures can be appreciably reduced by the application of suitable and properly maintained differential relaying.

The fire hazard can likewise be materially alleviated by the installation of some form of built-in fire extinguishers in cases where the importance of the equipment justifies the expenditure.

Bus Structures

The importance of the bus structure has been recognized by the manufacturers and they have made great advances toward the assurance of safety. There are a number of different styles of factory-built and fully-inclosed bus and switch structures now available.

There are several points, sometimes overlooked, which should be

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reviewed with reference to the design of field fabricated structures.

Almost invariably, there is an urge to allot too little space to the bus structure. This results in a tendency to crowd which produces insufficient, or at least questionable, clearances from the viewpoint of safety. The bus structure is important enough to demand recognition and every effort should be made to secure ample space not only for safe electrical clearances but also, for safe emergency and maintenance operations.

Tubular buses are subject to all of the considerations applicable to flat buses and, in addition, several others. Where tubular buses are used out of doors or in places where they are likely to be subjected to freezing weather, provision should always be made to prevent the entrance of moisture which might be trapped and frozen, thus bursting the tubing.

Disconnecting Switches

While disconnecting switches are seldom assigned to current interrupting duty, there is always a possibility that they may be opened, through error or in unusual circumstances, under load. In anticipation of such eventualities, it is essential that effective barriers or adequate inter-phase spacing be provided in the mounting arrangement, otherwise serious short circuits may result.

Any design involving the use of stick operated switches should specifically provide for an adequate number of sticks and their dry and convenient storage in the immediate vicinity of the switches. Where sticks are used for high-voltage switches, it is also, highly desirable to provide places for the quick and effective attachment of the rain shed ground conductors. These two points are most easily overlooked in connection with outdoor switching structures and their oversight may, sooner or later, lead to costly delays, if not serious accidents.

Oil Circuit Breakers

Practically all of the larger oil circuit breakers now obtainable are of the tank-per-break type. This construction does much toward reducing the possibility of trouble on one phase being communicated to another and also tends to limit the amount of oil involved in a case of trouble.

The present tendency of making some oil circuit breakers trip free in all respects except with respect to the emegency operating handle seems to be a very dangerous practice. It acts to impress the operator with the idea that the switch is trip free in all respects and may cause him to, unknowingly, assume unnecessary personal risks. It would, therefore, seem advisable to be absolutely certain that a switch which is trip free in any respect is certainly trip free on the emergency operating handle.

Instrument Transformers

Instrument transformers are almost universally associated with high potentials on their primary side. They constitute a hazard on the assumption that the transformer insulation may at some time break down and the primary potential be communicated to the secondary circuit. For this reason, it is imperative that the secondary or low side of all instrument transformers be effectively grounded as near the transformer as possible.

Station Battery

Most of the batteries used nowadays for switching purposes are of the acid type and various hazards are introduced by the acid electrolyte. Battery rooms, for this reason, require particular attention. When the battery is being charged, explosive gases are liberated and permanent and effective ventilation for the battery inclosure is essential to safety. In addition to this, there is always a possibility of acid containers being broken or turned over in the battery room. Any appreciable depth of acid on the floor would make correction practically impossible. Thus, battery rooms should be provided with pitched floors properly drained through vitrified pipe in order that any unexpected spillage may be immediately and effectively disposed of.

Transformers

Many advances have been made for the promotion of safety in transformer operation in the last few years. The conservator type of transformer reduces the fire and explosion hazards to a minimum by keeping the tank completely filled with oil at all times, precluding the likelihood of any combustible or explosive mixture within the tank. It further acts to preserve the quality of oil by exposing only a small surface to the atmosphere and this surface is usually at a temperature much below that necessary for rapid deterioration.

Whenever water-cooled transformers are installed in climates where freezing temperatures are expected, considerable care should be given to the layout of the cooling piping system in order to insure that it will not become frozen and thereby cut off the circulating water. This admonition seems perfectly obvious, yet for some reason or other, the possibility of freezing is quite frequently overlooked and the necessary provisions are not made until after the transformers are installed and in operation.

Ground System

In order that a ground system can function to its maximum efficiency, its design and layout should be based upon accurate calculations. These calculations should not only indicate the maximum current to ground, but also the maximum current to be expected from the failure of the individual pieces of equipment and various insulators.

Where grounding systems are inclosed within steel buildings, it is advisable to bond the copper to the building steel as frequently as convenient without introducing undue expense.

Provision should always be made for the protection of the operator in the case of hand-actuated disconnecting switches wherein the linkage between the hand operating mechanism and the switch is accomplished by metallic members. This protection may be effected by the expedient of requiring the operator to stand on an insulated bench or a properly grounded metallic platform. In either case, the hand operating devices should be adequately grounded, and the bench or platform made a permanent part of the structure. This will insure their use at all times and will eliminate the necessity of depending upon the operator for his own protection. In cases where the grounded metallic platform is employed, it should not only be effectively grounded, but should be adequately bonded to the operating handle. The carrying capacity of the bond should be such that the maximum current flowing over it will not produce a dangerous resistance drop between points of contact of the operator's hands and feet.

Switchboards

Unfortunately, switchboards are so varied in their purpose and ap-

(Concluded on page 381)

INDUSTRIAL ENGINEERING'S DATA SHEETS

RESUSCITATION

by the prone pressure method

AS soon as possible feel with your fingers in the patient's mouth and throat and remove any foreign body (tobacco, false teeth, etc.) If the mouth is tight shut, pay no more attention to it until later. Do not stop to loosen the patient's clothing, but immediately begin actual resuscitation. Every moment of delay is serious. Proceed as follows:

1. Lay the patient on his belly, one arm extended directly overhead, the other arm bent at elbow and with the face turned outward and resting on hand or forearm, so that the nose and mouth are free for breathing. (See Fig. 1.)

2. Kneel, straddling the patient's thighs, with your knees placed at such a distance from the hip bones as will allow you to assume the position shown in Fig. 1.

Place the palms of the hands on the small of the back with fingers resting on the ribs, the little finger just touching the lowest rib, with the thumb and fingers in a natural position, and the tips of the fingers just out of sight. (See Fig. 1.)

3. With arms held straight, swing forward slowly so that the weight of your body is gradually brought to bear upon the patient. The shoulder should be directly over the heel of the hand at the end of the forward swing. (See Fig. 2.) Do not bend your elbows. This operation should take about two seconds.

4. Now immediately swing backward so as to completely remove the pressure. (See Fig. 3.)

5. After two seconds, swing forward again. Thus repeat deliberately twelve to fifteen times a minute the double movement of compression and release, a complete respiration in four or five seconds.

6. Continue artificial respiration without interruption until natural breathing is restored, if necessary, four hours or longer, or until a physician declares the patient is dead.

7. As soon as this artificial respiration has been started and while it is being continued, an assistant should loosen any tight clothing about the patient's neck, chest or waist. Keep the patient warm. Do not give any liquids whatever by mouth until the patient is fully conscious.

8. To avoid strain on the heart when the patient revives, he should be kept lying down and not allowed to stand or sit up. If the doctor has not arrived by the time the patient has revived, he

What to Do First—

ELECTRICAL SHOCK—The victim must be freed from the contact as quickly as possible. Use a dry stick, dry rope, dry coat or other non-conductor. The use of your hands without protection is dangerous and may add another victim to the accident.

GAS ASPHYXIATION—The first thing to do is to get the patient into fresh air quickly. Fresh air does not mean out of doors in cold weather. Do not breathe gas yourself even for a short time.

DROWNING—Quickly remove the victim from the water and place him on the ground or other hard surface. If possible, have the head slightly lower than the rest of the body so that the water and other liquids will drain away from the victim.

should be given some stimulant such as one teaspoonful of aromatic spirits of ammonia in a small glass of water, or a hot drink such as coffee or tea, etc. The patient should be kept warm.

9. Resuscitation should be carried on at the nearest possible point to where the patient received his injuries. He should not be moved from this point until he is breathing normally of his own volition and then moved only in a lying position. Should it be necessary, due to extreme weather conditions, etc., to move the patient before he is breathing normally, resuscitation should be carried on during the time that he is being moved.

10. A brief return of natural respiration is not a certain indication for stopping the resuscitation. Not infrequently the patient, after a temporary recovery of respiration, stops breathing again. The patient must be watched, and if natural breathing stops, artificial respiration should be resumed at once.

11. In carrying out resuscitation it may be necessary to change the operator. This change must be made without losing the rhythm of respiration. By this procedure no confusion results at the time of change of operator and a regular rhythm is kept up.

An unconscious person becomes cold very rapidly, and chilling means a further strain on a vitality already weakened. Experience has shown that the cold to which the victims of gassing, electric shock, or drowning are often carelessly exposed is probably the most dangerous cause of pneumonia, and this disease is the most dangerous after-effect of all these accidents. As far as possible keep the patient covered and warm both during and after resuscitation. Use hot pads, hot water bottles, hot bricks, radiant heaters or other similar means, but remember that an unconscious man has no way of telling you when he is being burned. Do not permit the patient to exert himself. If it should be necessary to move him, keep him lying down.

MEDICINES AND MEDICAL HELP

Never give an unconscious man anything to drink. It may choke him. Medical science knows no drug which of itself will start the breathing in a patient whose breathing has already ceased.

There is great danger of prematurely ceasing resuscitation. Breathing has been re-established after eight hours of resuscitation in cases of electric shock and gas asphyxiation. Therefore, the ordinary and general tests for death should not be accepted, and a doctor should make several careful examinations and be sure specific evidence, such as the onset of rigor mortis, is present before the patient is pronounced dead.

It is recommended that employers arrange for frequent instruction, demonstration and regular practice of this method.

Fig. 1. Hands in place

Fig. 2. Pressure on

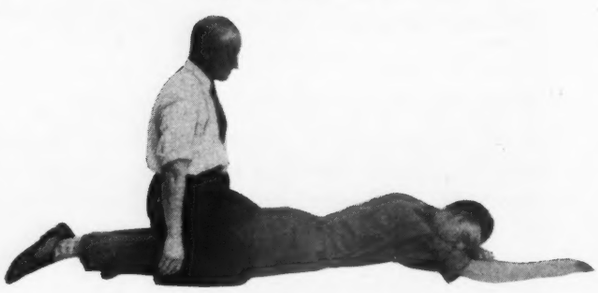

Fig. 3. Pressure off

Endorsed by the National Safety Council and the National Electric Light Association.

It Pays to Know Wire Rope Before Ordering

By DALE M. PERRILL
Mechanical Engineer

THROUGH contact with several operating engineers who work in various plants throughout the Chicago district, I have noted a marked confusion of thought among these men as to the basic difference between the seemingly conflicting terms used in connection with wire rope. The exact province of the varying kinds of "lays," just what each means and where each belongs, is not so thoroughly understood as it should be, even by men who are eminently capable as operating engineers. To the old hand, of course, these terms are elementary. For many, however, even extending to those in supervising or purchasing capacities, the terms that are so essential to intelligent use and application of wire rope seem only to contribute to clouded understanding and erroneous impressions. It is with the thought that much of this confusion might be clarified that I am setting forth the following facts.

Perhaps it is not to be wondered that many engineers carry impressions similar to one operator who believed that "Lang Lay" was a trade name signifying an individual brand of rope; or to a maintenance man who seemed quite surprised to learn that "Tru-Lay" did not signify a particular type of rope that differed in construction from ordinary ropes.

At another plant, an engineer was found who entertained the fallacious belief that "Right" and "Left" lay had no relation to either "Lang" or "Regular" Lay; while yet a fourth, a locomotive crane operator insisted upon ordering his rope by such specifications as: "⅞-in. 6x9 Plow Steel," expecting the rope manufacturer to supply his order without delay or confusion.

What "Construction" Means

Just a word about the construction of wire rope may be helpful to many. The wire rope that is commonly employed for practically all commercial purposes is made up into any one of 42 different constructions and in any one of six varying metals. There are, of course, many more than 42 different and distinct constructions, but by far the greater percentage of all wire rope service is performed by one of the 42 standard constructions. These varying constructions are designated by names such as "Seale," "Spacer Seale," "Warrington," "Tiller," and so on.

Practically all these several constructions are available in any one of six grades of material, which are: "Iron," "Toughened Steel," "Cast Steel," "Mild Plow Steel," "Plow Steel," and "Improved Plow Steel." Although it is quite impossible to set up an arbitrary table of wire rope application to definitely limit the province or define the service of any one rope, it yet remains that each of these 42 constructions and six different grades have places where they serve best and other places where, because they would be misapplied, would fail to give their full service life.

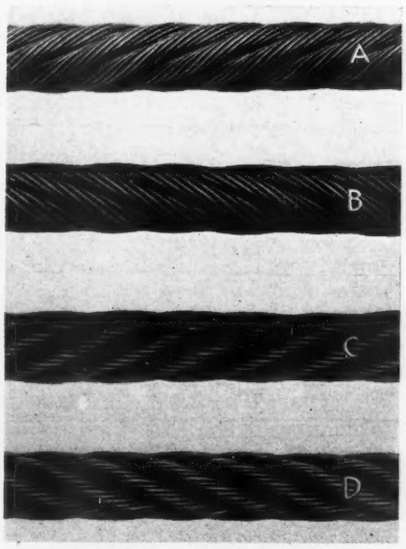

Fig. 1.—Lang Lay and Regular Lay construction. *(A)* Left Lay Lang Lay. *(B)* Right Lay Lang Lay. *(C)* Left Lay Regular Lay. *(D)* Right Lay Regular Lay.

In determining just which type of wire rope will best meet given conditions it always pays to consult a qualified rope engineer. Only through a knowledge of the working requirements and the condition of the auxiliary equipment can wire rope properly be specified.

Construction or grade of rope has no influence on its "lays," however. For instance, a 1¼ in. 6x19 Spacer Seale, which is to say: a 1¼-in. diameter rope that is made up of six strands of 19 wires each and in accordance with a construction known as "Spacer Seale," might be either Left Lay Lang Lay, Right Lay Lang Lay, Left Lay Regular Lay or Right Lay Regular Lay, or it might be any one of those, plus Tru-Lay.

What "Lay" Means

"Lay" signifies the manner in which the individual wires and strands are laid into the completed rope. The rope that is most commonly used is that of "Regular" Lay; so-called, because the wires in the strands are laid in the opposite direction to that in which the strands are laid into the completed rope. This construction is illustrated in Fig. 1, and it is commonly used in this country because, back in the old days when wire rope was forcibly twisted together rather than preformed (which meant locking within the rope a great deal of torsional stress) the internal stresses found themselves working in opposition to each other, that is, in one direction in the strands and in the opposite direction in the completed rope, with the result that the stresses did much to equalize themselves and make the rope less likely to kink; much less "cranky" and easier to handle than would be the case if both strand and completed rope stresses were pulling

in one direction. Whether the rope be Left Lay Regular Lay or Right Lay Regular Lay depends entirely on whether the strands are laid into the rope clockwise or counter-clockwise.

In an effort to provide the individual wires with a greater wearing surface and gain a more flexible rope, the principle of laying the wires and the strands was reversed. That is to say, the strands were laid into the completed rope in the same direction as were the wires into the strands. Fig. 1 illustrates this type of rope also. This is called "Lang Lay" rope.

As might be expected, this "Lang" lay rope offers several advantages over "Regular" Lay ropes, chief among which are:

(a) Greater wearing surface, each outer wire having approximately three times the length exposed for wear. (See Fig. 2.)

(b) Greater flexibility, because the outer wires of the strand are parallel to the axis of the rope against the manila core, and, therefore, set up less frictional resistance between themselves when bending.

(c) Lower bending stresses, the bending stress in a Lang Lay rope being approximately 80 per cent of that in a Regular Lay rope of the same construction and length of Lay.

However, there are several disadvantages to Lang Lay over Regular Lay rope, two of which are:

(a) When using Lang Lay it is absolutely essential that all auxiliary equipment, (sheaves, etc.) be in the best of condition since a pinching sheave, for instance, will more readily deteriorate Lang Lay than Regular Lay rope. It will be obvious that to squeeze or pinch a Lang Lay rope, that is, where the wires within the strands lay in the same direction as the strands within the rope, will more readily force the wires or strands to lift out of their proper place. This is called "bird caging;" a fault common to Lang Lay ropes that are made in the old way.

(b) By reason of the unopposed internal torsional stress in the non-preformed Lang Lay rope it has a great tendency to kink, be "cranky," and hard to handle. In addition, it will be "bird cage" more readily than Regular Lay and because of this fact is quite unsuited to tasks where there is a need for elasticity or sudden stopping and starting. In oil well drilling, as an instance, Lang Lay rope would be unsuited to the work of drilling because of the liability of the rope to "bird cage" due to the oft-repeated sudden jars.

As in all ropes, Right Lay Lang Lay or Left Lay Lang Lay may be determined by whether the strands are laid in the rope clockwise or counter-clockwise.

The word "Tru-Lay," known in connection with wire rope, does not signify a rope of a particular construction or grade. It is a copyrighted trade name for the brand of rope manufactured by one company. According to this manufacturer, "Tru-Lay" is rope in which both

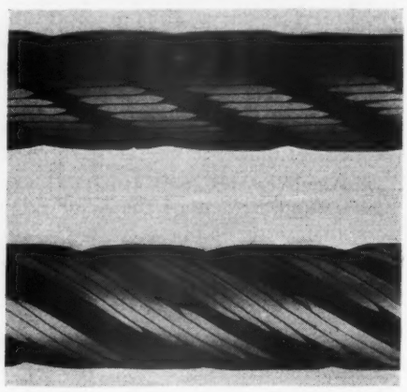

Fig. 2.—Partially worn Regular Lay *(above)* and Lang Lay wire rope.

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wires and strands are preformed before being assembled into the completed rope.

How to Order Wire Rope

No doubt, every wire rope manufacturer is repeatedly receiving orders which read something as follows: "Please ship us 242 ft. of 5/8-in. Improved Plow Steel rope," or "Ship by express 80 ft. of 7/8-in. Seale." Such orders cannot be filled until more information is secured as to the type and kind of rope required. And when a user has an elevator stalled or a locomotive crane laid up for want of a rope the delay involved in obtaining more information is frequently very costly.

In ordering wire rope there are nine distinct pieces of information required. These are:

1. Length of rope.
2. Diameter of rope. (Before replacing an old rope it is always well to gage the sheave to ascertain whether it has been worn to an extent that will cause excessive abrasion or pinch the new rope.
3. Numerical construction. The number of strands by the number of wires in each strand. For instance, 6x7, 7x9, 6x19, and so on.
4. Type of construction such as Seale, Spacer Seale, Guy, Warrington, etc. If in doubt or if ignorant of the exact construction, consult a qualified wire rope engineer.
5. Grade, whether Plow Steel, Improved Plow Steel, and so forth.
6. Direction of Lay, whether Right or Left.
7. Type of Lay, whether Lang or Regular.
8. Type of core, whether hemp center or independent wire-rope center.
9. A full description of the class of service for which the rope is intended.

Where more than one rope is used on a piece of equipment, specify which rope is required, as: A boom rope or a hoist rope on a revolving shovel.

Written properly, the order that originally might have read: "242 ft. of 5/8-in. Plow Steel rope," would more correctly read; "242 ft. of 5/8-in. 6x19 Warrington, Plow Steel, Left Lay, Regular Lay, with hemp center. This is to be used for hoist line on derrick."

If wire rope users will order their rope in accordance with these specifications they will save themselves many costly delays and assure themselves a more uniformly high average of rope service.

National Electrical Exposition to Be Held in New York

AN exposition to visualize the development of the many applications of the electrical industry for household and commercial use has been planned under the sponsorship of the Electrical Board of Trade of New York, and the New York Electric League. This exhibit, known as the National Electrical Exposition, will be held at the Grand Central Palace, New York, N. Y., October 7 to 12, 1929.

It will introduce to the electrical trade, the electrical user and to the domestic consumer, developments and applications of electricity for every purpose and every use. Domestic commercial and industrial equipment will be featured.

From 10 until 2 p. m. daily admission will be restricted to the trade and the industrial user. The general public will be admitted from 2 p. m. until closing.

Correct Solders and Fluxes Save Maintenance Time and Labor

By JAMES SILBERSTEIN

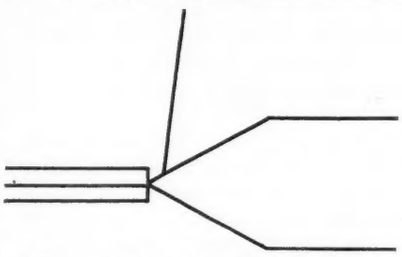
THE making of good and reliable solders is now a highly specialized business, and the products are for the most part the result of careful tests and patient research work. The purpose of this article is to describe from the user's point of view what kind of solders and fluxes should be used for different purposes, and how the soldering operation should be performed in order to save time, labor and material. The article deals only with soft solders, that is, solders which melt below 600 deg. F., and which can be worked with a soldering iron.

Solders for Mechanical Work

Solders generally consist of alloys of lead and tin in different proportions, the most common having equal parts. Where strength of the soldered joints is important, and hard or brazing solders are not desired, the alloy which contains 42 per cent tin and 58 per cent lead should be used, since this alloy is the strongest of the series. The solder used for wiping pipe joints consists of 66 per cent lead and 34 per cent tin. Antimony is a metal which always occurs in small amounts in solders, and it is often added deliberately to half-and-half solders in an amount up to 2 per cent to improve the appearance of this dull, leaden-looking alloy in order to give it a smooth bright surface. However, where toughness and resistance to vibration are essential as for instance, for automobile radiators, antimony is not desired since it has been found that solders containing this element under vibration exhibit intercrystalline failure. In this country an antimony content of up to one-half of 1 per cent is often allowed for automobile radiator solders, while in some European countries the antimony content is limited to two-tenths of 1 per cent.

The price of tin is higher than that of lead, and the cost of solders decreases, therefore, with decreasing tin content, consequently solders low in tin are used where the cost item is of prime importance. Such solders are, however, more difficult to work, and the saving in cost of the solder is, therefore, often off-set by an increase in cost of labor. Only in cases where the time required for soldering is comparatively small, for instance, when passing the joints to be soldered through a molten bath of solder, is it of advantage to use solders having a tin content as low as 15 per cent.

All commonly employed lead-tin solders start to fuse at a temperature of 358 deg. F., and joints soldered



When soldering joints in a horizontal position have but one edge of the soldering iron tinned and feed the solder as shown.

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with any of these alloys will, therefore, break down if heated to or above this temperature. Where ability to withstand higher temperatures is required, tin, with a fusion temperature of 446 deg. F., an alloy containing 90 per cent lead, 9 per cent cadmium and 1 per cent zinc with a fusion temperature of 476 deg. F., or an alloy containing 97¼ per cent lead, ¼ per cent copper and 2½ per cent silver with a fusion temperature of 576 deg. F. can be used. If still higher temperatures are encountered in service, or if the mechanical stresses on the joints prohibit the use of soft solders, brazing or so called hard solders must be employed.

Although solders are purchased under trade names they can be obtained also according to chemical composition. If ordered according to chemical composition from a reliable concern, the purchaser is safe in getting his product at a fair price.

As a summary of the foregoing, it may be concluded that the 40 per cent tin 60 per cent lead, or the 42 per cent tin 58 per cent lead solders are best suited for general-purpose mechanical work.

Solders for Electrical Work

The requirements of solders to be used on electrical apparatus are rather severe. A necessary requirement is the workability of the solder with non-corrosive fluxes. Harmful elements such as zinc and cadmium should not be present. The flowing qualities of the solders must be very good, and the copper content of lead-tin solders should not be over 0.05 of one per cent. Many electrical joints are subjected to vibration and since the joints are heated by the electric current flowing through them it is evident that the requirements as to toughness and tenacity are more severe for electrical solders than for others.

Lead-tin solders, containing equal parts of lead and tin, or 42 per cent tin and 58 per cent lead, are commonly used in soldering electrical joints, since they fulfil the requirements mentioned previously. In cases, however, where temperatures approaching the fusion point of these solders are encountered, they are not suitable because the joints will fail in the course of time. Solders having higher fusion points must be employed in such cases. It is the opinion of some electrical engineers that alloys high in tin, for instance 80 per cent tin and 20 per cent lead, or 90 per cent tin and 10 per cent lead, have higher fusion points and, therefore, are superior to ordinary solders. This belief has been proved incorrect theoretically and by practical experience. Pure tin, which has a fusion point of 446 deg. F., has been used in such cases, but since this temperature is only 88 deg. F., above that of lead-tin solders, the superiority of pure tin is not very marked. A solder with a fusion point of 576 deg. F., or 218 deg. F., above that of lead-tin solders has been developed. This

solder, which consists of lead as the base metal to which 2½ per cent silver and ¼ of 1 per cent copper have been added has been used with satisfactory results in a great number of cases where other solders failed.

Some engineers are inclined to believe that hardness is an indication of resistance, both to vibratory stresses and to heat. There is, however, absolutely no foundation for such a belief. On the contrary, excess hardness is accompanied by brittleness, which, certainly, is not desirable for solders. Neither has hardness and strength any relation to the ability of a solder to withstand high temperatures. Solder throwing in electrical motors is primarily caused by the heat developed in the motor, which at times is so high that the solder partly liquefies and, therefore, is thrown out due to the speed of rotation.

Fluxes and Soldering Operation

Mechanical Work—A solution of zinc chloride or killed acid is the flux generally used in soldering, except for delicate work. This flux can be made up easily and cheaply in the following way: Put a quart of hydrochloric acid (also called muriatic acid) in an earthenware vessel or in some other suitable container. Place it where the fumes and gases can escape freely into the open air. Add one ounce of sal ammoniac and pieces or clippings of zinc. An effervescence will take place at once. Do not add too much zinc at one time. When the addition of zinc causes no further effervescence in the solution, the acid is said to be killed. As flux, it is ready for use. Zinc chloride and other acid fluxes induce subsequent corrosion, and all excess of such fluxes therefore, should be thoroughly washed away after soldering. Where delicate work is to be soldered, or when conditions do not permit the washing away of excess flux, non-corrosive fluxes which are described later in this article, should be employed.

The joints used are numerous but some form of lap joint is most common. A joint is made as follows: The surfaces of the members are scraped or rubbed clean with emery paper and brushed with the flux. A bar or strip of solder is taken in one hand and a heated soldering iron in the other. Both are drawn in contact with each other and with the joint. The solder melts and follows the course of the flux. A variation on this method is what is termed sweating which is suitable for large areas. The surfaces are cleaned and coated with solder which is spread over the surfaces with the soldering iron. The surfaces are then brought together and heated until the solder melts and unites.

It is important to remember the following items in soldering:

(A) The members to be joined should be fitted as closely together as possible. This treatment results in the best joint.

(B) The edge of the soldering iron should be filed smooth. A rough edge results in a poor job and waste of solder.

(C) Solder does not stick to cold metal. The surface of the metals to be soldered must be heated to the fusion point of the solder in order to bring about amalgamation. This state is not readily noticeable where parts of thin gage are soldered, but it is more noticeable the heavier the parts are. Very often, it is an advantage to preheat articles to be soldered, since a saving in time and labor is effected.

Electrical Work—The use of non-corrosive fluxes in soldering electrical work is imperative. The flux generally used consists of a solution of resin in alcohol. This flux is easily made up by dissolving one pound of the best grade of resin in one quart of alcohol. The importance of using only the best grade of resin can hardly be over-estimated. Poor grades contain gummy compounds, which upon heating deposit carbonaceous material, thus preventing the solder from sticking to the metal. An instance is recalled where a manufacturer of electrical apparatus experienced considerable trouble in soldering, and only after an extensive investigation was it found that a cheaper grade of resin had been substituted in the flux for the grade previously used. The saving which the purchasing agent has imagined turned out to be a loss, and the use of the cheaper grade of material had to be discontinued.

Though there are several non-corrosive fluxes on the market used for soldering electrical apparatus, the alcohol-resin-flux is by far the cheapest, even when using the best grade of resin, and it is used most commonly. A flux in paste form which is used by several manufacturers has the following composition: Sal ammoniac 1.5 per cent; glycerine 14.5 per cent; white Vaseline 84 per cent. This flux is made up as follows: The glycerine is heated to a temperature of from 180 to 240 deg. F., and the sal ammoniac is stirred in until it is dissolved. The vaseline is then added in portions and the liquid stirred well. The flux thickens on cooling to a pasty mass and it is then ready for use.

Since electrical joints have to carry current as well as withstand the heat generated by the current, it follows that the resistance of the joints should be small. The areas of contact consequently should be large.

In soldering practice it is essential to hold the soldering iron in contact with the joint for as long a time as is required for the solder to flow in and fill the joint entirely. The importance of this point should not be underestimated. It has happened repeatedly that reducing the time for soldering has resulted in poor contacts with subsequently overheating of the joints and failure of the machine.

It goes without saying that the points which have to be observed in soldering mechanical work also apply to the soldering of electrical work.

Solders for electrical apparatus are generally in strip form or wire shape in order to facilitate the feeding of the solder into the joint. On many occasions it is necessary to hold the soldering iron in a horizontal or nearly hosizontal position. In this case as shown in the sketch, only the upper side of the soldering iron should be tinned. If both sides are tinned the result is that part of the solder runs through the space between the soldering iron and the metal part against which it is held, no matter how firmly the iron is held against the metal. The solder which runs through and drops on the floor is, as a rule, greater than the part which flows into the joint. The floor spillings are, of course, not lost, since they can be remelted, but they are naturally dirty and there is danger of contamination from other metals, which reduces their value considerably. By tinning the upper side of the soldering iron only, the solder flows first into the joint, the superfluous solder then drops to the floor. It is evident that saving not only in solder but also in time and labor is thus effected. In shops where much soldering is done, the saving that can be made by tinning the upper side of the iron only will, in a short time, amount to quite an item.

Types of Bearings Used in Transmission of Power

(Continued from page 348)

type bearing, because it is much more independent of lubrication. Its ultimate efficiency does not depend to any marked degree upon the manner of lubrication, for the function of a lubricant is really more to protect the highly polished surfaces of the rolling elements than to serve as a means of reducing friction, carrying journal loads, or removing heat from the bearing.

Roller and ball bearings for industrial head-, line-, jack-, and countershafting are three to four times more costly than a first-class babbitted bearing, but this disadvantage is soon overcome by friction load reduction, oil saving, increased length of life, and low maintenance.

Flexible Steel Roller Hanger Bearing.—This bearing, Fig. 19, is made of cast iron and is equipped with two sets of rollers. It is manufactured for shafting $1\frac{7}{16}$ in. to 3 in. in diameter and within these sizes will fit any type of hanger frame, size for size.

The rollers are wound right and left hand and, therefore, continuously carry the lubricant back and forth over the entire bearing surface. These bearings require lubrication approximately four times per year for average service.

Solid Steel Roller Hanger Bearing.—This bearing, Fig. 20, employs hardened and ground solid-steel rollers held in position by a cage. The rollers do not touch the shaft, but operate in a steel bushing which clamps on the shaft. The elements of the entire box are split, thus making it easy of application.

Tapered Steel Roller Hanger Bearing.—The type of lineshaft roller bearing shown in Fig. 21 is a radical departure from the flexible or solid-roller type for this class of service. It consists of two tapered roller bearings mounted on a ground steel tube and fitted to an accurately-machined, cast-iron housing. This type of hanger bearing is not split and, therefore, must be slipped over the end of the shafting.

Ball-Bearing Hanger Box.—One of the standard types of ball-bearing hanger boxes is shown in Fig. 22. They are substantial in construction and designed to insure long life under any conditions that are likely to be met in lineshaft transmission. The bearing is designed for thrust as well as radial loads.

This type of bearing is made for shafting up to 6 in. in diameter and will fit any hanger, size for size. It is of solid construction and, therefore, must be slipped over the end of the shafting.

Ball-Bearing Ball-and-Socket Pillow Block.—In this type of antifriction pillow block, Fig. 23, the raceways, balls, and cages are of the same design as used in ball-bearing hanger boxes, but the structure as a whole is designed for a different service. It is constructed with full ball-and-socket features and thus readily accommodates itself to misaligned or sprung shafting. When antifriction bearings are desired, this bearing should be employed on lineshafting supported from walls or on concrete or wooden supports. It is manufactured for shafting up to 6 in. in diameter. The ball races are solid; therefore the bearing must be slipped over the ends of the shafting. The housing, however, is capped.

Ball-Bearing Rigid Pillow Block.—This type of antifriction pillow block is called rigid only because it cannot adjust itself in a vertical plane without the aid of adjusting wedges on a baseplate. It can adjust itself to shafting irregularities in a horizontal plane because of the ball bearings. This bearing is small and compact and can readily be secured in place. The ball bearings proper must be slipped over the ends of the shafting, but the housing is capped. Fig. 24 illustrates a practical application of the ball-bearing pillow block.

The Incorporation of Safety in Electric Station Design

(Continued from page 374)

plication that it is impossible to discuss them in generalities. This applies particularly to the numerous systems of relay protection incorporated in them.

Probably one of the greatest safeguards to service so far as switchboards are concerned is the proper and permanent marking of all terminals and connections. This practice materially eliminates errors in checking and maintenance, and makes incorrect operation a matter of carelessness rather than ignorance or uncertainty.

Cables and Conduit

Conductor and cable failures for purely electrical causes, due to the choice of improper types of insulations are rather infrequent but such failures have resulted from attempting to operate particular insulations at idle temperatures sufficiently high to cause a deterioration of the insulating material.

There is one precaution in connection with the design of conduit and cable systems which merits attention and is quite frequently overlooked. This is the matter of protecting conduit runs against the entrance of rats, mice and other small animals, the activities of which have been known to result in several insulation failures. Apparently this is a small matter but the cost of screening or otherwise closing the conduit openings is usually an excellent investment.

Lightning Arresters

Lightning arresters, like all other conducting equipment, have a very definite maximum current carrying capacity. When this limit is exceeded, the arrester not only ceases to function properly, but is usually totally destroyed. Thus, the application of lightning arresters should be carefully coordinated not only with the nominal operating voltage and the maximum rated voltages of the equipment to be protected but also with the synchronous capacity available to deliver current to ground through the arrester.

Conclusion

In retrospect, it would seem that modern electrical structures are generally safe with reference to normal operating conditions and that most of the existing or potential hazards result from a failure to properly evaluate the apparently minor points and to accurately anticipate the unexpected.

NEW EQUIPMENT

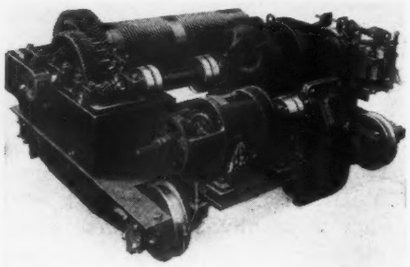
For Plant Operation and Maintenance

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these new devices which are designed to improve plant operation or reduce operating and maintenance costs.

Whiting "Tiger" Crane

THE "Tiger" is the name given to the crane recently developed by the Whiting Corporation, Harvey, Ill. The crane employs herringbone gears in the hoisting train, trolley rack gears and bridge drive. The use of these gears may be called the chief feature of the crane, because their employment necessitated many other improvements which evolved this design.

Hyatt roller bearings have been made standard at all points except the sheave bearings and the squaring shaft bearings which carry no weight. Gears operate in a continuous oil bath with all bearings completely inclosed in oil-



Whiting "Tiger" Crane

tight cases. The mechanical brake is lubricated and cooled by a forced lubrication arrangement made possible by taking advantage of the pumping action of the herringbone gears. Axle and drum bearings are lubricated by the Alemite system.

The trolley frame is welded, which reduces the dead weight to be overcome in starting and stopping.

Atomister "Paint-O-Mister" Spray Gun

ANNOUNCEMENT has been made by the Atomister Corporation, Rahway, N. J., of the development of an improved spray gun known as the "Paint-O-Mister."

Among the outstanding features of this unit, according to the announcement, are the following: (1) All one piece gun with pistol style grip, (2) Finger rest, (3) Hand rest, (4) Two finger easy pulling trigger, (5) Air valve with port hole to by-pass air when not spraying and motor is running, (6) Hook to hang gun when not spraying, (7) Spray volume regulating

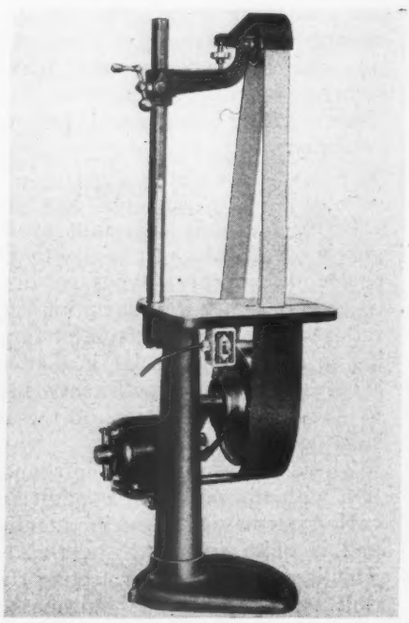
Atomister "Paint-O-Mister" Spray Gun

valve increases or reduces volume by mere turn of the valve button to right or left, (8) One fluid jet for all materials, (9) Lock ring to keep air nozzle in position and to prevent air leakage, (10) One air nozzle for both round and flat spray adjusted by a half turn either way.

Porter-Cable Syracuse Belt Sander

A FLEXIBLE belt sander adapted for sanding small irregularly shaped articles and which is designated as the "Syracuse," Type B6, has been introduced by the Porter-Cable Machine Company, Syracuse, N. Y. It is operated in a manner somewhat similar to that of a band saw.

The machine, as shown in the illustration, consists of a small pedestal and work table through which an abrasive belt runs vertically. It is designed to accommodate belts from ½ to 3 in. in width and from 95 to 125 in. in length. The vertical adjustment is accomplished by means of the movable arm supporting the upper pulley.



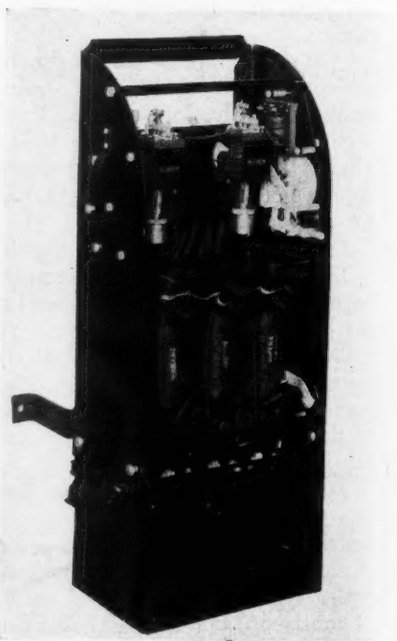
Porter-Cable Machine Company Belt Sander

The Type B6 is motor-driven, power being transmitted by means of a belt. The sander can be equipped for two speeds; 1,975 f.p.m. for wood, or 3,425 f.p.m. for metal. It is portable and can be operated from a power line or by merely plugging into the nearest lamp socket.

G. E. Compensators for Gaseous Atmospheres

FOR use in places where there are explosive gases or fumes, the General Electric Company, Schenectady, N. Y., has developed a hand-starting compensator designated as CR-1034-N-52. This is a modification of standard equipment so designed as to eliminate exposed arcing.

The starting switch on this device is oil-immersed. In addition, the usual push-button tripping device is not in-



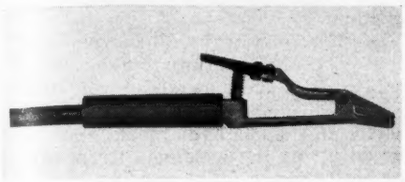
General Electric Manually-Operated Compensator for Use in Atmosphere of Explosive Gases

cluded in the equipment, but instead, a standard time-delay undervoltage attachment and dashpot relays are used with Cooper-Hewitt mercury tubes substituted for the usual contact tips of the dashpot relays. As a result of this arrangement, exposed sparking or arcing at contacts is eliminated.

This compensator is available for use with 25- to 60-cycle, two- or three-phase, 110-volt motors up to 15-hp. rating, and with 220-, 440-, and 550-volt motors up to 125-hp. rating.

G. E. Welding Electrode Holder

AS a supplement to its line of electric arc welding equipment, the General Electric Company, Schenectady, N. Y., announces a clamp type electrode holder. This device has jaws of heavy



G. E. Welding Electrode Holder

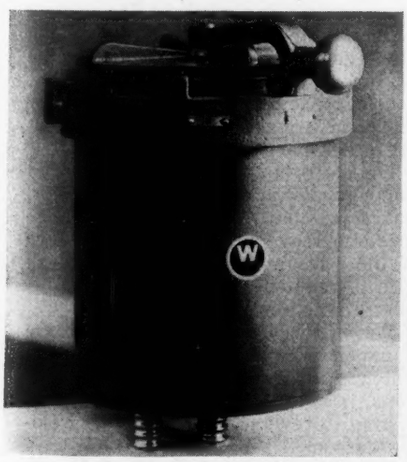
copper alloy, notched to hold firmly any size of electrode wire from 1/16 to 1/4 in. in diameter, in any position.

A molded-compound handle protects the operator from heat and from contact with current-carrying parts. The holder is designed for use with currents up to 300 amp. It may be obtained, if desired, assembled with five feet of extra-flexible cable and terminal.

Westinghouse Explosion-Tested Type Controller

ADDING to their line of explosion-tested type motors and controllers, the Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa., announces a controller of the drum type which provides across-the-line starting for a small d.c. motor.

The controller is provided with fuses mounted inside of the controller case and interlocked with a screw-type cover to meet the requirements of the U. S. Bureau of Mines for explosion-tested equipment. Accessibility is one of the features of this small controller, which is provided for by mounting the entire controller on the bottom base. The bottom base is threaded to screw into a cylindrical case. Removing this case uncovers the entire controller for inspection or maintenance.



Westinghouse Explosion-tested Type Controller for Small Motor

The controller is designed as a small compact unit for application on permissible-type conveyors, pit car loaders, room hoists, small pumps and similar types of apparatus where explosion-tested equipment is required.

Acorn Heater Changes Name

ANNOUNCEMENT has been made by the Acorn Heater Corporation, Bridgeport, Conn., of the change of name to The Electric Heater Corporation, due to confusion resulting from a similarity between the established Acorn trademark used by Harvey Hubbell, Inc., and an Acorn trademark used by a Western range manufacturer.

With the above change in name, the name of "Acorn Instantaneous Water Heaters" has been changed to Instantaneous Electric Heaters, and the Acorn trademark has been replaced by a new Instantaneous trademark.

Roth Brothers Now a Division of Century Electric

ANNOUNCEMENT has been made by the Century Electric Company, St. Louis, Mo., of the acquisition of Roth Brothers and Company, Chicago, Ill., manufacturers of d.c. industrial power motors, d.c. generators for industrial power and lighting, a.c. generators, motor-generator sets for moving picture projectors, broadcasting, television, battery charging, signal systems, etc., and several specialties.

Although Roth Brothers and Company will be operated as a division of Century Electric Company, some of the foregoing items will now be manufactured in the Century Company's plant in St. Louis, Missouri.

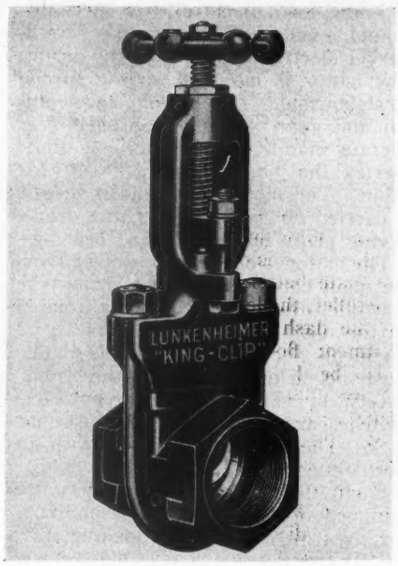
Lunkenheimer "King-Clip" Gate Valves

THREE designs in gate valves, designated as the "King Clip," have been developed by the Lunkenheimer Company, Cincinnati, Ohio, for use on steam, oil, gas, air, water and gasoline lines.

All three types: Rising-stem inside screw; Outside screw and yoke and Quick-operating are procurable in iron-body bronze-mounted and all-iron patterns with screw or flanged ends. Thread lengths accommodates American Standard and A. P. I. line pipe. The flange-end valves have flanges of the 125-lb. American Standard for iron flanges and are plain faced.

A screwed stuffing box nut is used in valves up to 3 in. inclusive; sizes 1 to 3 in. inclusive have gland followers. A bolted iron gland is used in 3½- and 4-in. valves.

Iron-body bronze-mounted valves, inside screw patterns, have iron body and bonnet; bronze bonnet bushing, disk, seat rings and stem. Quick-operating sliding-stem patterns are of similar material construction to the in-



Lunkenheimer "King-Clip" Gate Valves

side screw patterns except that the handwheel is replaced by an iron lever attachment which permits practically instantaneous valve operation. Outside screw and yoke valves have iron body, yoke and gland; bronze yoke bushing, disk, seat rings and stem.

Pressure ratings of King-Clip gate valves are as follows: Screw ends ¼ to 2 in. inclusive, 150 lb. working steam pressure, 225 lb. gas or liquid pressure; screw ends 2½ to 4 in. inclusive and flange ends 1½ to 4 in. inclusive, 125 lb. working steam pressure, 175 lb. gas or liquid pressure.

Elwell-Parker 15-Ton Tiering Truck

A FIFTEEN-TON tiering truck suitable for assembling or handling machinery has been developed by the Elwell-Parker Electric Company, Cleveland, Ohio. It is known as their Type ELB-30, Hi-Lo Tructor and is designed to operate with an Exide Iron-Clad battery of 24 cells.

Lifting the load is accomplished by means of one cable on the motor-driven hoist drum which is mounted over the battery compartment. These cables run over sheaves at the top of the elevator uprights, thence down to the elevator carriage which is assembled integral

Elwell-Parker 15-Ton Tiering Truck

with the load platform. A specially-wound, fully-inclosed type Elwell-Parker electric motor drives the drums. The motor is mounted on the special hoist housing. The driving bevel pinion and gear, worm and bronze gear operate in oil. The worm-gear shaft carries the hoist drum grooved for cable. The motor and gear reduction is carried on ball bearings, the drums having plain, bronzed-bushed bearings.

The motor is operated by power from the main battery through a drum-type controller, the lever of which is situated on the dash beneath the battery compartment floor. The control handle must be held to operate the truck. Safety limits and emergency trip switches are located on the hoist unit deck. The motor is equipped with an electro-mechanical brake.

Each of the four trail wheels are equipped with two 15x15-in. solid-rubber tires distributing the loading over the largest floor area possible, yet reducing the unit floor loading to the smallest amount possible consistent with practical steering.

Reynolds Drum Controller

FOR use wherever it is expedient to open or close electrical circuits by automatic means, the Reynolds Electric Company, Chicago, Illinois, has developed an automatic motor-driven drum controller which, it is claimed, will successfully preclude all human inaccuracies or errors.

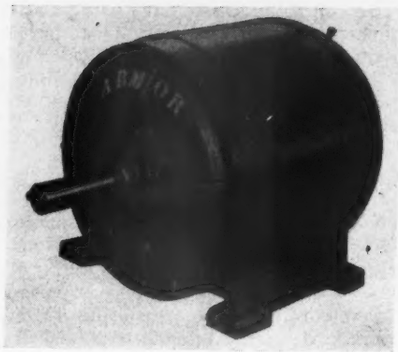
The announcement further states that this control will make and break circuits as fast as 500 times per minute and as slow as once every 15 min., handling up to 50 amperes.

Armor Electric Timken-Equipped Motors

THE Armor Electric Manufacturing Company has recently developed a line of Timken-equipped explosion and abrasion proof, totally-inclosed electric motors in ratings of from ½ to 50 hp., 550, 440 and 220 volts, two and three phase, 25 and 60 cycles. The motors are of the squirrel-cage induction type, and suitable for use, it is claimed, under conditions where the atmosphere is liable to be impregnated with explosive fumes or abrasive dust.

The stator is of the skeleton-frame type, the frames being made of heavy castings with the feet cast integral. The windings are of the concentric type with one phase per slot. All end coils are completely taped and thoroughly insulated, the stator being impregnated with a moisture and acid-resisting compound varnish.

The end shields consist of solid castings with heavy external ribs supporting an external ring. The Timken rotor bearings are mounted between the caps which are bolted to the end shield proper. The caps have fine grooves on the inner surface which extend from 1 to 2 in. along the shaft, and have



Armor Electric Timken-Equipped Motor

from 0.001 to 0.005 clearance. Grease forced into these grooves under pressure produces a seal which is both dirt and gas proof. After assembly all motors are tested hydraulicly at 75 lb. per square inch internal pressure.

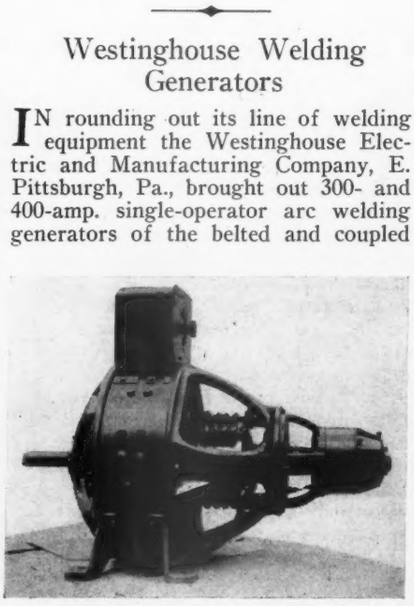
G. E. Direct-Current Cam Switch

A DIRECT-CURRENT cam switch designated 3108, and developed to fit the needs of central stations for such a device to control auxiliaries such as pumps, blowers, etc., has been introduced by the General Electric Company, Schnectady, N. Y. The switch can also be used for similar non-reversing applications where the current inrush or starting torque is not severe or the operations are not frequent.

The switch is available in two forms. Both are for non-reversing service with armature regulation over five points, while one form has field regulation over 22 points. The intermittent armature current capacity is 1,000 amperes, while the same capacity, continuous rating, is 500 amperes. The switches are rated 550 volts, maximum.

Westinghouse Welding Generators

IN rounding out its line of welding equipment the Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa., brought out 300- and 400-amp. single-operator arc welding generators of the belted and coupled



Westinghouse 400-amp. welding generator

type which may be used where driving power such as motors, gasoline engines, tractors, lineshafting, etc., are already available.

The complete unit includes a generator, a direct-connected exciter, a control panel, and a reactor. The generators have small overall dimensions to permit mounting where space is a premium.

The control for the unit is mounted on top of the generator frame and is inclosed in a sheet metal cabinet. The control includes a voltmeter, an ammeter, and a single-dial field rheostat for adjusting the welding current over the entire range. The welding current range of the 300-amp. unit is 90 to 175 amp. while that of the 400-amp. unit is 120 to 500 amperes,

The generators are all special Type SK, single-operator, constant-current, differentially compound-wound, separately-excited machines. Due to the separate excitation feature, variations of arc length or intensity are automatically compensated for by instantaneous changes of generator voltage.

These welding generators are all rated in accordance with the recently revised N. E. M. A. Standards. The units are of the single-operator type, but multiple operator generators can be furnished in standard 500, 750 and 1,000 amp. ratings.

Lincoln "Stable-Arc" Welders Feature Unified Control

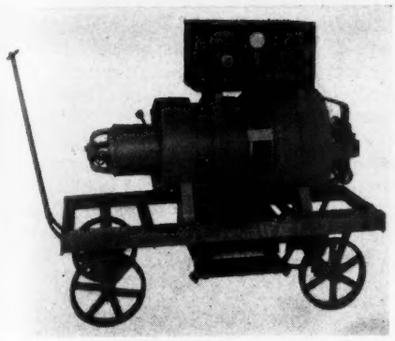
UNIFICATION of the controls of both motor and generator is one of the outstanding features in the improvements incorporated in the "Stable-Arc" welders according to an announcement made by the Lincoln Electric Company, Coit Rd. and Kirby Ave., Cleveland, Ohio.

The working mechanism of all controls is contained in a ventilated inclosed steel cabinet with hand regulators and switches mounted on a panel which forms a side of the cabinet. The control panel contains rheostat regulator, diverter switch, safety starter switch, volt-ammeter and wing nut terminals for cables. The control cabinet is mounted directly over the motor generator for easy access by the welding operator. This arrangement also permits the removal of the motor generator armature without disturbing any other parts.

The use of a combined voltmeter and ammeter, designated as a volt-ammeter, makes possible the reading of voltage and amperage on one dial. The face of the volt-ammeter is mounted flush with the control panel assuring the utmost protection possible.

Terminals for lead cables are equipped with winged nuts, a feature which makes quick and easy connections possible, especially when it is desired to reverse the polarity of welding current.

The Lincoln Safety Push-Button switch is incorporated in the control panel for starting and stopping of the



Lincoln 300-amp. Portable Welder for A. C. Supply

welder. With this type of switch it is impossible to accidentally start the welder, it is stated. Inclosed wiring of all operating controls as well as a metal backed rheostat are the result of the use of a unified control cabinet. The mounting of this cabinet over the motor generator permits the use of a shorter chassis frame or base than used in previous models. The shorter base offers the advantage of less floor space occupied by the welder as well as a smaller turning radius of the portable models.

Specialty Brushes for Inside Cleaning

CUP AND END BRUSHES have been developed by the Specialty Manufacturing Company, 10698 Berea Road, Cleveland, Ohio, for the purpose of cleaning interiors of tanks, barrels, boilers, tubes, castings, and other maintenance and production jobs where the ordinary circular brush is not effective.

They may be used either on a polishing spindle or in conjunction with flexible shaft equipment, and may be made up into gangs for any desired shape of brush surface. They are available in all regular sizes and of any desired stiffness of wire or bristle.

For corners and orifices so narrow that even the cup brush cannot do a good job, the end-brush is used. This is inserted in a chuck or holder on the end of a driving shaft. The use of these brushes is not confined to interior work. The end brush in particular can be used for exterior cleaning, but in such cases the ordinary type of perfect balance brush is generally preferable.

G. E. Control Switch for Circuit Breakers

A CONTROL switch for the remote operation of circuit breakers has been placed on the market by the General Electric Company, Schenectady, N. Y. This switch is known as the "Turn-Pull" switch because a combined turning and in or out motion is required to operate it.

The handle is oval in shape and carries a metal strip insert that makes it possible to tell at a glance which operation was last carried out by the attendant. There are two positions of the handle: right for close, and left for trip.

The main closing and tripping contacts are of the pivoted-shoe type, and are operated by the initial outward or inward motion of the switch shaft. The turning motion then operates four auxiliary, silver-tipped contacts through the action of cams. Two of the latter contacts are placed in series with the main contacts, so that it is impossible to actuate the circuit breaker until the indicating switch handle is swung into the right or left position. The second pair of contacts is used singly; one for an indicating lamp, and the other in the alarm bell circuit.

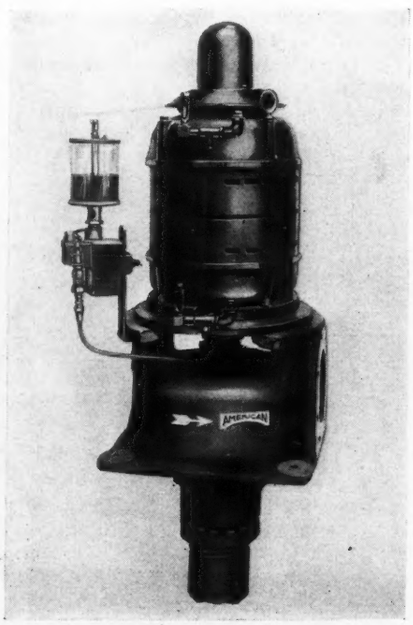
American Well Works Deep-Well Turbines

THE American Well Works, Aurora, Ill., announce the development of 6- and 8-in. Deep-Well Turbines, which have been built in response to a demand for turbines to fit smaller bored wells.

The deep-well turbine consists of the turbine head proper which is the driving unit, the supporting pipe which encloses the driving shaft, and the turbine itself which consists of the number of stages necessary for the specific requirements.

The turbine head consists of the vertical motor mounted on a very rigid and compact base. The thrust bearing of the motor is designed to carry the load of the line shaft and impellers. To the turbine head is attached the supporting pipe, to the lower end of which is attached the turbine proper. All bearings are oil lubricated by gravity feed from the surface, the gravity feed being electrically controlled.

Provision is made for complete drainage of all waste oil and water leakage.

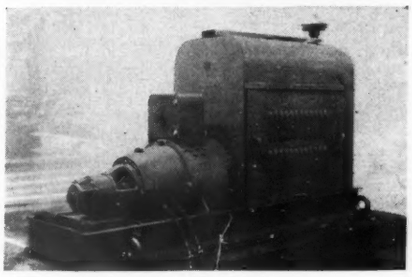


American Well Works Deep-Well Turbine

Westinghouse Gas-Engine Driven Welding Set

WESTINGHOUSE Electric and Manufacturing Company, E. Pittsburgh, Pa., announces the marketing of a 300-amp., gas-engine driven, single-operator arc welding set for the purpose of supplying welding current where a local power supply is not available as in the case of pipe line and storage tank construction, steam railroad construction, maintenance work, structural steel work, general construction and repair jobs in isolated places.

The complete set consists of a model P-35 Continental 4-cylinder gas engine, direct connected to a 300-amp., single-operator, Type SK, arc welding generator with a flexibly-coupled exciter overhung from the generator bracket.



Westinghouse Gas-Engine Driven Arc Welding Set

The Continental Red Seal engine has the S.A.E. rating of 28.9 hp. Under average operating conditions, the fuel consumption is approximately 1½ gallons per hour; the gasoline tank holding 28 gal. For lubrication, the pressure feed system with a gear-type pump is used.

Wheeler Reflector Duratach Fixtures

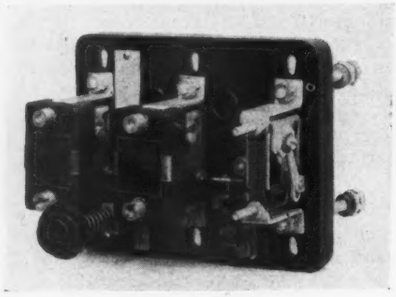
THE Wheeler Reflector Company, Boston, Mass., has announced the development of Duratach Fixtures, a modern construction which allows ease of installation, greater interchangeability of lighting equipment, and a material reduction in maintenance cost, it is claimed.

Duratach construction, consists of a socket base attached to a canopy by two screws which fit into bayonet holes in the socket base. The socket shell is attached to the Duratach socket by contact prongs which extend from the top of the socket shell and which are engaged in recesses in the socket base. The socket shell is permanently supported in the reflector neck by means of a metal disk which rides on a metal shoulder incorporated in the reflector neck construction.

According to the manufacturer all mechanical and electrical connections are made in one operation. It also states that any Duratach canopy, when the reflector is removed, can be used as a convenient outlet to receive a standard attachment plug.

G. E. Relays

A COMPLETE line of double- and triple-pole temperature overload relays is now offered by the General Electric Company, Schenectady, N. Y. The principal advantages of the line are in the construction, which allows the user to remove and insert heating elements when necessary, and which allows the use of a third relay unit on the same base when it is desired to protect three legs of a circuit.



G. E. Temperature Overload Relays with renewable heaters

The line is divided into two parts, bearing the designations TC-121 and TC-131. The TC-121 relays are designed for the protection of two legs of a circuit, while the TC-131 provides an element for the protection of a third leg. Both forms are rated in current-carrying capacity from 30 to 150 amp., and are available for either front or back connecting.

The back-connected forms are for panel mounting, but use the same base as on the front-connected forms. On inclosed panels, air drafts are eliminated by the inclosing case, but on open panels it is necessary to use a cover over the relay.

An electric reset is provided as an accessory. When used with a relay which is mounted at the bottom of a base, a sub-base is added. This is clamped to the main base by the relay itself. Where there is sufficient space, the reset relay can also be mounted on the panel.

Meriam Combination Manometer

A MODIFICATION of the regular U-tube manometer placed on the market by the Meriam Company, Cleveland, Ohio, permits the instrument to be used either as a flow meter or as a pressure indicator. The operation of the instrument depends upon the fact that all manometers operate upon the differential principle, whether rate of flow or actual pressure is indicated.

When a manometer is used to read pressure of liquids or gases, one of the arms is connected to the atmosphere and the other to the source of pressure to be measured. The difference in liquid levels in the two arms shows the difference between the pressure measured and that of the atmosphere. When a manometer is used to indicate flow of liquids or gases, the two U-arms are connected one on each side of an alloy steel disk connected in the pipe line whose flow is to be measured. The steel disk has an orifice of known size, and this produces a definite drop of pressure for a given rate of flow. This drop is shown on the manometer, which is calibrated to read rate of flow. Hitherto, it has been necessary to use two manometers when both pressure and flow readings were required, but the instrument described herein, according to the announcement, avoids this difficulty by the use of a simple extra device.

G. E. Insulating and Protecting Coatings

FOR sealing joints in gas mains, for painting structural iron, motors, oil tanks, fire hydrants, mine machinery and similar equipment requiring sealing and insulating paints, the General Electric Company, Schenectady, N. Y., is offering a series of lacquers in colors for use where an oil-resistant, highly-protective, durable and flexible insulating coating is demanded. The base of the lacquers is an alkyd resin produced from phthalic anhydride and glycerine marketed under the trade name "Glyptal."

These lacquers are available in five colors—red, blue, brown, green and aluminum. They may be applied by brushing, spraying, or dipping. They dry, dust free, in about 30 min., and in approximately ten hours give a hard, smooth finish which is easily cleaned. When using Glyptal lacquers as a finish, no priming or sizing is necessary, it is stated. No. 1201 red Glyptal lacquer is recommended for sealing joints against oil, water and gas leaks. Blue, brown and green Glyptal lacquers, Nos. 1206, 1210, and 1211, respectively, are primarily for finishing purposes. Aluminum Glyptal lacquer, No. 1212, withstands extremely high temperatures, and tests show that discoloration is practically imperceptible at 600 deg. F. It is recommended for use on metal subjected to high temperature.

Glyptal lacquers may be obtained in half-pint, pint, quart, one and five-gallon cans, and 52-gal. drums.

Worthington Timken-Equipped Compressors

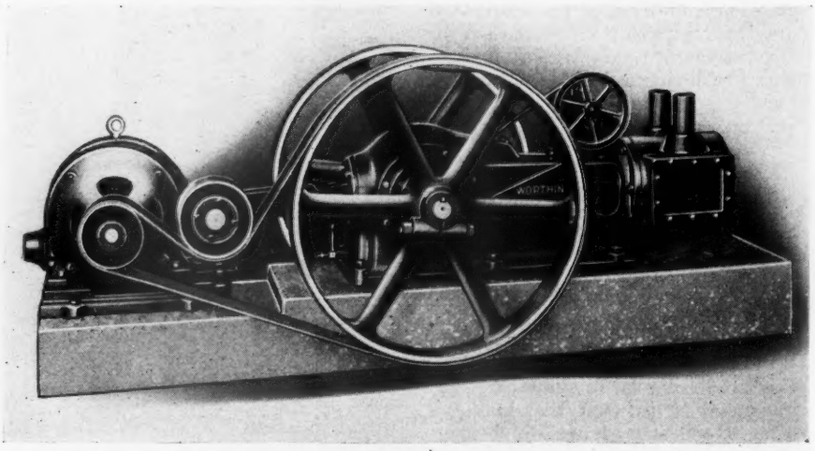
A LINE of compressors employing Timken roller bearings on the main crank shaft journals has been announced by the Worthington Pump and Machinery Corporation, Harrison, N. J. This is the Worthington single, horizontal, straight-line series with a range from 100 to 300 cu. ft. per minute.

Oil rings, which deflect the surplus oil and return it to the crankcase are mounted on the shaft beyond the Timken bearings. A special feature is the design of the crankcase inclosure. This is completely oil tight, and free from oil leaks usually found in equipment of this kind.

"Feather Valves" are standard equipment on these machines, as they are on all Worthington air and gas compressors. These valves are light strips of steel approximately 1/32 in. thick, which flex when opening against a curved guard to permit the passage of air.

Regulation may be by an automatic starter and pressure switch mounted on the motor, stopping and starting it to control the air pressure between definite limits. Or a pressure regulator may be attached to the compressor inlet valves holding them open to maintain constant air pressure. Compressors with the latter type of unloader, which by-passes the air back to suction, are claimed never to overheat when unloading.

These compressors can be furnished with ball-bearing idlers for short-belt drive; with Texrope drives using V-type ropes; or a synchronous motor may be directly mounted on the compressor crank shaft, thus eliminating transmission mechanism.



Worthington Timken-Equipped Compressor

Wallace Workace Electric Shaper

A PORTABLE motor-driven electric shaper has been introduced by the J. D. Wallace & Company, 134 So. California Ave., Chicago, Ill. This machine is direct motor driven with the armature shaft; the shaper spindle is

Wallace Workace Electric Shaper

integral. The belt has been eliminated to avoid slipping and the resultant slowing down of operation and loss of power.

The Workace electric shaper has a no load speed of 10,000 r.p.m. It is ball bearing equipped. The lubrication system is designed to prevent any of the surplus oil from reaching the motor. The excess is picked up and thrown by a slinger away from the armature shaft and drained outside of the housing. The table is mounted on a screw on which it may be raised or lowered and locked in position by means of a handwheel.

The spindle is a steel shaft 5/8 in. in diameter, extending 3 5/8 in. above the table top and has a capacity of 2½ in. between two steel shaper collars or 3¼ in. using solid cutters.

The shaper is driven by a G.E. universal motor which may be used on the ordinary lighting circuit, 110 or 220 volts d.c. or a.c., 25 to 60 cyles. The complete machine weighs 42 lb. and sits firmly on its base without fastening.

American-La France and Foamite Alfite (Carbon Dioxide) Portable Hand Extinguishers

PRODUCTION of Alfite (Carbon Dioxide) portable hand extinguishers in 7½ and 15-lb. sizes for extinguishing fires in gasoline, fuel and motor oils, paints, alcohol, as well as fires in electrical switchboards, etc., has been announced by the American-LaFrance and Foamite Corporation, Elmira, N. Y. Both models are equipped with a cone-shaped horn which is designed to provide the maximum concentration of Alfite gas at the point of the fire.

Alfite gas as contained in these two portable extinguishers, as well as in the larger stationary units manufactured by this firm, is a special grade of carbon-dioxide gas which is sealed in the cylinders in a liquid state. When the extinguishers are actuated by raising a control handle, a plunger ruptures a copper disk and allows the liquefied gas to escape. Maximum efficiency is assured in all Alfite extinguishers, it is claimed, because of the fact that their construction makes them freeze-proof and their specially constructed valve guarantees against leakage.

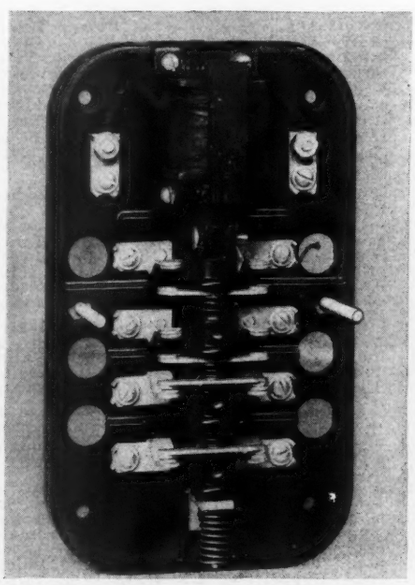
G. E. Multi-Finger Relay

THE General Electric Company, Schenectady, N. Y., announces a relay, designated as CR-2820-1080, designed to meet the demand for a multi-finger, a.c. device for general purpose use.

This relay consists of a series of double-break, silver-faced fingers operating horizontally and controlled by a small solenoid. The power consumption of the solenoid coil is eight watts. Creepage and clearance for 550 volts have been provided. The contacts will carry 15 amp. continuously.

By varying the arrangement of the contact fingers, the relay may be arranged for a number of different types of application such as: four fingers normally open; three fingers normally open, one closed; two fingers open, two closed; three open; two open, one closed; one open; two closed; two open; one open; one closed; two closed.

The relay may be used when a number of independent circuits are to be controlled remotely and on signal and indicating circuits, emergency throw-over controls and similar applications.

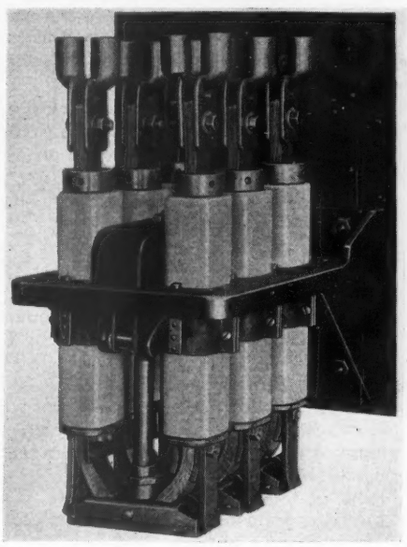


G. E. C. R. 2820-1080, Multi-Finger Relay

Roller-Smith Oil Circuit Breakers

THE Roller-Smith Company, 233 Broadway, New York City, announces an addition to its lines, namely, Type "O" Oil Switches and Circuit Breakers.

The Type "O" oil switches are made



Roller-Smith Type "O" Oil Circuit Breaker

in capacities from 200 to 2,000 amp., from 2,500 to 15,000 volts and with interrupting capacities from 20,000 to 40,000 kva. They are made as two-pole and three-pole devices, automatic and non-automatic, single and double throw for switchboard, wall and cell mounting; also for hand operation, normal and remote control and electrical operation.

G. E. Pressure Governor

AN improved design of its CR-2922 pressure governor, designated as Form B1, has been announced by the General Electric Company, Schenectady, N. Y. According to the announcement the changes result in improved appearance, greater strength of some vital parts, simplification and generally better electrical design.

To increase the reliability of the governor, the impulse-type relay has been replaced by a potential relay. On low pressure, the relay is energized and remains energized through a holding interlock until the relay coil is shorted out on high pressure through a series resistance. The contact and gage mechanism has been made very rugged and special provision has been made to prevent the gage mechanism from getting out of alignment with the contact mechanism. The Bourdon tubes on gages of 300-lb. rating and below are mounted two in parallel, one actuating the needle and the other the contact mechanism as a means of insuring accuracy in operation and indication.

TRADE LITERATURE

You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog desired, as given in these columns.

(139) ARC WELDING—An educational motion picture portraying the construction of arc-welded pipe lines is offered gratis for showing upon application to the Lincoln Electric Company, Cleveland, Ohio.

(140) ELECTRIC HEAT—"Electricity for industrial heating" illustrates applications of electric heat.—Commonwealth Edison Company, Chicago, Ill.

(141) CLUTCHES—Loose-leaf Catalog containing various sizes and types of clutches, also a catalog assembled to show clutch applications to different machines for each industry, and problems in that particular industry.—The Carlyle Johnson Machine Company, Manchester, Conn.

(142) BELT TENSION DEVICE—Leaflet on applications and illustrated descriptions of cantilever-spring Beltslacker.—Harry M. Perry, 638 N. Main St., Los Angeles, Calif.

(143) CIRCUIT BREAKERS—Supplement No. 1-A to Bulletin No. 580 covers recent additions to the line of Type EAF air-break circuit breakers.—Roller-Smith Company, 233 Broadway, New York, N. Y.

(144) SPEED REDUCERS—A 16-page circular No. 1831, "Westinghouse-Nuttall Single-Reduction Mill Units," describes and illustrates helical and herringbone gear units for heavy-duty drives.—Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.

(145) FLEXIBLE COUPLINGS—Circular 1838, an 8-page publication describing the construction, application and maintenance of Type E flexible couplings.—Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.

(146) GEARS—Micarta, Silent Gears and Pinions, a 20-page booklet, No. C-1579-F.—Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.

(147) CONCRETE FLOORS—"Reducing the Ratio of Soluble Constituents in Portland Cement Concrete"; a brief discussion of the factors which cause the disintegration of concrete floors and the results of experiments for its prevention.—Master Builders Company, 7016 Euclid Ave., Chicago, Ill.

(148) UNIT HEATERS—A new bulletin contains some interesting facts about industrial heating together with detailed descriptions of Wing units.—L. J. Wing Manufacturing Company, 154 West 14 St., New York, N. Y.

(149) METALAYER—A recent folder describes this system which simultaneously melts, atomizes and applies a coating of molten metal of any desired thickness.—Metals Coating Company of America, 497 North Third St., Philadelphia, Pa.

(150) SWITCHBOARDS—Folder 5181, "Quality Switchboards," gives the important advantages of steel switchboards.—Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

(151) WIRE ROPE—A recent circular describes Roebling "Blue Center" Steel wire rope.—John A. Roebling's Sons Company, Trenton, N. J.

(152) AIR COMPRESSOR—Bulletin A-50 describes the construction and application of the "Triple-A" Centrifugal compressor.—Allen Air Appliances Company, Inc., 452 Lexington Ave., New York, N. Y.

(153) WATER WHEELS—Bulletin W203 is the first of a series on typical Leffel water wheel installations.—The James Leffel & Company, Springfield, Ohio.

(154) STEEL PIPE NIPPLES—Booklet Commercial Standard CS5-29-Steel Pipe Nipples has just been issued.—Commercial Standards Group, Bureau of Standards, Washington, D. C.

(155) JFS VARIABLE REDUCER TRANSMISSION—A new bulletin describes in detail the several types of this transmission unit.—Stephens-Adamson Manufacturing Company, Aurora, Ill.

(156) SAFETY STARTER—The Lincoln Across the Line Safety Starter and Safety Push Button is the subject of a recently issued bulletin.—The Lincoln Electric Company, Coit Road and Kirby Ave., Cleveland, Ohio.

(157) CRANES—A 48-page book, No. 1095 describes the complete line of Link-Belt gasoline, Diesel, electric and steam-operated cranes, and shovels and draglines.—Link-Belt Company, 910 So. Michigan Ave., Chicago, Ill.

(158) TIERING MACHINES—Bulletin 85A, "The Art of Piling" is the first of a series written for users of tiering and stacking machines.—Revolvator Company, 336-352 Garfield Ave., N. J.

(159) ELECTRICAL PRODUCTS—Supplement No. 1 to Benjamin Catalog 24 is now ready for distribution.—Benjamin Electric Manufacturing Company, Des Plaines, Ill.

(160) MOTOR STARTERS—Folder G7 contains a very simple and clear description of the construction and operation of the new Lincoln Across Line Safety Starter.—The Lincoln Electric Company, Cleveland, Ohio.

(161) LUBRICATION—"Houghton on Industrial Plant Lubrication," is the first of a series of booklets on this subject prepared by the Houghton Research Staff. Copies may be had upon request.—E. F. Houghton & Company, Third, American and Somerset Sts., Philadelphia, Pa.

(162) GAS BOOSTERS—Victor Gas Boosters for gas burning furnaces or oven installations and also booster service on distribution lines are described in Bulletin No. 233.—The Connorsville Blower Company, Connorsville, Ind.

(163) HIGH VOLTAGE INDICATOR—This safety device, used to indicate the presence of highly charged cables is the subject of a recently issued folder.—The Martindale Electric Company, 1260 West 4th St., Cleveland, Ohio.

Coming Events

National Association of Power Engineers—47th Annual Convention, Chattanooga, Tenn., Sept. 9 to 13, inc. The Power and Mechanical Exhibition will be conducted in conjunction with the convention. Ivon F. Pieters, president, Plibrico Jointless Firebrick Company, 1800 Kingsbury St., Chicago, Ill. S. M. Chapman, secretary, 5909 Kennerly Ave., St. Louis, Mo.

Chattanooga Power and Mechanical Exposition, in conjunction with 47th Convention of the National Association of Power Engineers. Chattanooga, Tenn., Sept. 9-13, inc. Frank N. Chapman, care of A. Leschen & Sons Rope Co., 5909 Kennerly Ave., St. Louis, Mo., secretary of the National Exhibitors' Association.

Illuminating Engineering Society—23rd Annual Convention, September 24 to 27 incl., Bellevue-Stratford Hotel, Philadelphia, Pa., Illuminating Engineering Society, 29 West 39th St., New York City.

National Electric Exposition—Oct. 7 to 12 incl., Grand Central Palace, New York, N. Y. Managers, Fred W. Payne and Charles F. Roth, 480 Lexington Ave., New York, N. Y.

National Factory Show—The first National Factory and Industrial Production Exposition will be held in Chicago in the early part of 1930. G. E. Pfisterer, president, The National Factory and Industrial Exposition, 308 West Washington St., Chicago, Ill.